Specifications

For

Tulalip Tribes
Battle Creek Hatchery

Tulalip, WA
January 2025

100% Design Specifications

Stantec Consulting Services, Inc.

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SPECIFICATION STAMPS AND SIGNATURES

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PROFESSIONAL CERTIFICATION

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Washington, License No. 47046, Expiration Date: 8/31/2025

David E. Whitbeck
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PROFESSIONAL CERTIFICATION

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Washington, License No. 22019831, Expiration Date: 8/8/2025.

Charles Williams
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PROFESSIONAL CERTIFICATION

I hereby certify that these documents were prepared or approved by me, and that I am a duly registered architect under the laws of the State of Washington, License No. 20105228, Expiration Date:8/1/2026.

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PROFESSIONAL CERTIFICATION

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Washington, License No. 42872, Expiration Date: 08/15/2025

Jeff Lynch
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PROFESSIONAL CERTIFICATION

I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Washington, License No. 31294, Expiration Date: 1/25/2027

John C. Deerkop, P.E.
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SPECIFICATIONS

DIVISION 01 – GENERAL REQUIREMENTS

01 10 00	Summary of Work
01 25 00	Substitution Procedures
01 26 00	Contract Modification Procedures
01 29 00	Payment Procedures
01 31 00	Project Management and Coordination
01 32 00	Construction Progress Documentation
01 33 00	Contractor Submittals
01 33 17	Structural Design, Support and Anchorage
01 40 00	Quality Requirements
01 50 00	Temporary Facilities and Controls
01 60 00	Product Requirements
01 71 00	Mobilization
01 73 00	Execution
01 74 20	Gravity Pipeline Testing
01 74 30	Pressure Pipe Testing
01 74 40	Concrete Structure Testing
01 75 00	Installation and Startup
01 75 10	Commissioning
01 77 00	Closeout Procedures
01 78 39	Project Record Documents
01 79 00	Owner Staff Training

DIVISION 02 – EXISTING CONDITIONS

02 41 19	Demolition and Reconstruction

DIVISION 03 – CONCRETE

03 01 30	Concrete Repair and Rehabilitation
03 11 00	Concrete Forming
03 21 00	Reinforcement Steel
03 31 00	Cast-In-Place Concrete
03 32 00	Joints in Concrete
03 35 11	Concrete Floor Finishes
03 60 00	Grouting

DIVISION 05 – METALS

05 05 19	Post-Installed Anchors in Concrete
05 12 00	Structural Steel Framing
05 50 00	Miscellaneous Metalwork
05 52 00	Aluminum Railings

DIVISION 06 – WOOD, PLASTICS, AND COMPOSITES

06 10 00 Rough Carpentry
06 41 16 Plastic-Laminate-Clad Architectural Cabinets
06 64 00 Plastic Paneling
06 80 00 Fish Rearing Equipment

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 13 26 Self-Adhering Sheet Waterproofing
07 21 00 Thermal Insulation
07 26 00 Vapor Retarders
07 84 13 Penetration Firestopping
07 84 43 Joint Firestopping
07 92 00 Joint Sealants

DIVISION 08 – OPENINGS

08 11 13 Steel Doors and Frames
08 36 13 Sectional Doors
08 51 13 Aluminum Windows
08 71 00 Door Hardware
08 80 00 Glazing

DIVISION 09 – FINISHES

09 29 00 Gypsum Board
09 51 13 Acoustical Panel Ceilings
09 65 16 Resilient Sheet Flooring
09 68 13 Tile Carpeting
09 72 00 Wall Coverings
09 91 23 Interior Painting
09 96 00 Protective Coating
09 96 12 Polyethylene Tape Wrapping for Pipe

DIVISION 10 – SPECIALTIES

10 14 23 Panel Signage
10 28 00 Toilet, Bath, and Laundry Accessories
10 44 16 Fire Extinguishers
10 51 13 Metal Lockers

DIVISION 11 – EQUIPMENT

11 30 13 Residential Appliances

DIVISION 12 – FURNISHINGS

12 24 13	Roller Window Shades
12 48 13	Entrance Floor Mats and Frames

DIVISION 13 – SPECIAL CONSTRUCTION

13 34 19	Metal Building Systems
13 34 21	Pre-Engineered Metal Canopies

DIVISION 22 – PLUMBING

22 05 13	Common Motor Requirements for Plumbing Equipment
22 05 17	Sleeve and Sleeve Seals for Plumbing Piping
22 05 18	Escutcheons for Plumbing Piping
22 05 19	Meters and Gages for Plumbing Piping
22 05 23. 12	Ball Valves for Plumbing Piping
22 05 23. 14	Check Valves for Plumbing Piping
22 05 29	Hangers and Supports for Plumbing Piping and Equipment
22 05 33	Heat Tracing for Plumbing Piping
22 05 48	Vibration and Seismic Controls for Plumbing Piping and Equipment
22 05 53	Identification for Plumbing Piping and Equipment
22 07 19	Plumbing Piping Insulation
22 11 16	Domestic Water Piping
22 11 19	Domestic Water Piping Specialties
22 11 23.13	Domestic-Water Packaged Booster Pumps
22 11 23.21	Inline, Domestic-Water Pumps
22 13 16	Sanitary Waste and Vent Piping
22 13 19	Sanitary Waste Piping Specialties
22 33 00	Electric, Domestic-Water Heaters
22 42 13.13	Commercial Water Closets
22 42 16.13	Commercial Water Closets
22 42 16.16	Commercial Sinks
22 42 23	Commercial Showers
22 45 00	Emergency Plumbing Fixtures
22 47 13	Drinking Fountains

DIVISION 23 – HVAC

23 05 17	Sleeves and Sleeve Seals for HVAC Piping
23 05 18	Escutcheons for HVAC Piping
23 05 29	Hangers and Supports for HVAC Piping and Equipment
23 05 48	Vibration and Seismic Controls for HVAC
23 05 53	Identification for HVAC Piping and Equipment
23 05 93	Testing, Adjusting, and Balancing for HVAC
23 07 13	Duct Insulation
23 07 19	HVAC Piping Insulation
23 09 23. 12	Control Dampers
23 09 93. 11	Sequence of Operations for HVAC
23 31 13	Metal Ducts
23 33 00	Air Duct Accessories
23 33 46	Flexible Ducts
23 34 16	Centrifugal HVAC Fans
23 37 13. 13	Air Diffusers
23 37 13. 23	Registers and Grilles
23 72 23. 13	Packaged, Indoor, Heating Wheel Energy Recovery Units
23 81 29	Variable Refrigerant Flow HVAC Systems
23 82 36	Finned Tube Radiation Heaters
23 82 39. 19	Wall and Ceiling Unit Heaters

DIVISION 26 – ELECTRICAL

26 00 00	Electrical Work General
26 01 10	Electrical Operation Maintenance Data
26 01 11	Electrical Operation Maintenance Manual
26 01 26	Electrical Tests
26 01 90	Electrical Spare Parts and Maintenance Materials
26 05 00	Common Work Results for Electrical
26 05 10	Electric Motors
26 05 15	Industrial Control Panels
26 05 19	Wire and Cabling
26 05 26	Grounding
26 05 29	Hangers and Supports for Electrical Systems
26 05 33	Electrical Raceway Systems
26 05 35	Motors and Motorized Actuators
26 05 43	Underground Raceways Systems
26 05 48	Vibration and Seismic Controls for Electrical Systems
26 05 53	Identification for Electrical Systems
26 05 73.13	Short-Circuit Studies
26 05 73.16	Coordination Studies
26 05 73.19	Arc-Flash Hazard Analysis
26 05 83	Wiring Connections

26 09 13 Electrical Power Monitoring
26 09 23 Lighting Control Devices
26 12 16 Panelboards and General-Purpose Dry Type Transformers
26 23 03 Enclosed Switches
26 23 04 Disconnect Switches
26 24 13 Switchboards
26 27 26 Wiring Devices
26 28 13 Fuses
26 29 23 Variable Frequency Drive Units
26 32 13 Standby Power Generation
26 36 00 Transfer Switches
26 43 00 Surge Protection Devices
26 50 00 Lighting
26 52 13 Emergency and Exit Lighting
26 56 13 Lighting Poles and Standards

DIVISION 27 – COMMUNICATIONS

27 05 26 Grounding and Bonding for Communications Systems
27 11 00 Communications Equipment Room Fittings
27 11 16 Communications Racks, Frames, and Enclosures
27 13 13 Communications Copper Backbone Cabling
27 13 23 Communications Optical Fiber Backbone Cabling

DIVISION 28 – FIRE ALARM SYSTEM

28 31 11 Digital, Addressable Fire Alarm System

DIVISION 31 – EARTHWORK

31 10 00 Site Preparation
31 13 00 Tree Protection and Trimming
31 23 19 Dewatering
31 30 00 Earthwork
31 34 19 Geotextiles
31 90 00 Gravity Retaining Wall

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 11 13 A.C. Pavement and Base
32 31 13 Chain Link Fencing

DIVISION 33 – UTILITIES

33 05 16	Precast Concrete Manholes and Vaults
33 05 31.11	PVC Gravity Sewer Pipe
33 16 00	Fiberglass Reinforced Plastic Storage Tanks
33 40 00	Stormwater Utilities
33 92 20	Ductile Iron Piping (AWWA C151, Modified)
33 95 34	Large Polyethylene Pressure Piping
33 95 40	Small PVC Non-Pressure Piping, Rubber Joints (ASTM D 3034, Modified)
33 95 46	PVC Drainage Pipe
33 95 50	PVC Pressure Piping, Rubber Joints (AWWA C 900, Mod)

DIVISION 40 – PROCESS INTERCONNECTIONS

40 05 00	Piping, General
40 05 02	Piping Identification
40 05 06	Pipe Couplings
40 05 07	Pipe Supports
40 05 17	Copper Water Tube
40 70 30	Instruments
40 91 00	SCADA Systems and Equipment
Attachment A	Instrument Schedule

DIVISION 42 – PROCESS HEATING, COOLING, AND DRYING EQUIPMENT

42 51 00	Chiller System

DIVISION 43 – MATERIAL HANDLING EQUIPMENT

43 20 00	Pumps, General
43 25 05	Submersible Sump Pumps
43 30 00	Valves, General
43 30 12	Valves and Gate Actuators
43 30 14	Butterfly Valves
43 30 16	Check Valves
43 30 18	Ball Valves
43 30 20	Gate Valves
43 30 52	Miscellaneous Valves
43 30 62	Slide Gates
43 30 67.23	Pressure Regulating Valves
43 40 10	Fiberglass Reinforced Plastic Tanks
43 52 04	Portable Davit Crane and Hoist

DIVISION 46 – MATERIAL PROCESSING AND HANDLING EQUIPMENT

46 01 00	Equipment General Provisions
46 21 33	Drum Filters
46 21 34	Pressurized Screen Filters
46 21 56	Intake Fish Screens
46 34 22	Circular Center Feed Clarifiers
46 41 83	Packed Column Aerators
46 66 63	Open Channel LPHO UV Disinfection System
46 66 64	Closed Vessel UV Disinfection System

APPENDIX

Appendix A	Control Philosophy
Appendix B	Geotechnical Design Report

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SECTION 01 10 00 – SUMMARY OF WORK

Part 1 -- GENERAL

1.1 THE SUMMARY

A. This Section includes the following:

1. Work covered by the Contract Documents.

2. Use of premises.

3. Tribal occupancy requirements.

4. Specification formats and conventions.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: Battle Creek Hatchery.

1. Project location: 6731 Totem Beach Rd. Tulalip, WA 98271.

B. Technical Coordinators:

1. Point of Contact

Michael Crewson
Tulalip Tribes
6406 Marine Drive
Tulalip, WA 98271
Phone: 360-716-4626
Email: mcrewson@tulaliptribes-nsn.gov

C. The Work involves construction of a new chum salmon hatchery. Improvements include mechanical components for a production well, a concrete water supply headbox with aeration for both surface water and well water, incubation building, water intake and pump station, wastewater clarifier, effluent drum filter, eight 26-ft diameter circular rearing tanks, and ten early rearing troughs.

Well water will be obtained from the existing production well located in the NE corner of the property. The screen and casing are installed but no additional mechanical components. Well water is pumped to a well water storage tank with a packed column aerator mounted at the top. Space for a second aerator is provided for a future well. The outflow from the storage tank is routed directly to the Incubation Building for use in the vertical incubation stacks and Kitoi boxes. Well water from the storage tank may also be directed to the headbox to supplement surface water supply.

Surface water for grow out operations will be obtained from Battle Creek from the reservoir created by the existing diversion dam. The surface water supply will be diverted through an intake structure equipped with a trash rack and cylindrical fish screens, then into a wet well containing submersible intake pumps. The pumped water is directed to packed column aerators, drum filters, and UV disinfection units located in the Water Supply Headbox. The

headbox is used primarily to distribute surface water to the circular tanks, but also can provide surface water to the Incubation Building or to a drain. An overflow weir box maintains water levels during operation.

The hatchery will feature both vertical incubation (Heath) stacks and Kitoi boxes for incubation. The Kitoi boxes are intended to be used for excess or surplus eggs and will be connected to a small fry tank with ability to transfer to circular tanks using a forklift. Well water is intended to be the primary supply for incubation, but surface water is also available from the headbox. A chiller system is also included for use in otolith marking. A formalin treatment room is provided in the Incubation Building for storing formalin barrels. The formalin system inside the formalin room will be provided by others. When formalin is used, valves are provided to direct the effluent into a formalin holding tank that has a pump to slowly pump out the water to meet label dilution requirements.

Following egg hatch and swim up, the fry are intended to be transferred to circular tanks for grow out. The side drain outlet of the tanks captures the cleaner effluent and may be routed to the Battle Creek in-river pond or downstream below the diversion dam. The bottom drain is directed to a drum filter for solids removal prior to discharge below the dam. A fish release pipe is also connected out of the center drain to allow fish to be moved directly out to Battle Creek Pond without handling.

A drum filter will be provided to treat effluent from the circular tanks. This will be done to avoid overwhelming the clarifier when peak flow occurs (approximately 2000gpm). The clarifier tank is provided to settle concentrated backwash from the screen filters and drum filters on site. A rake mechanism is used to promote settling. Sludge can be removed from the clarifier by the OWNER's Vactor-Truck.

D. Project will be constructed under a single prime contract.

1.3 USE OF PREMISES

A. Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

B. Schedule operations so that Work is conducted during regular office hours which are weekdays between 7:30 am to 5:00 pm.

C. Schedule and sequence operations necessary to complete the work, including coordination with other crafts relative to the Contractor's requirements. Schedule Work in such manner as to avoid delays in overall construction and permit proper installation of work.

D. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Tribal Occupancy: Allow for Owner access of Project site. Tribal personnel will require periodic access to areas of the hatchery near the diversion dam for adult return monitoring and harvest. Conduct work in a manner that will minimize needs for disruption of normal operations. Provide minimum 72 hours advance notice to Tribe Point of Contact of activities that will impact normal operations. Secure written approval of activities that will impact normal hatchery operations to avoid delays in overall construction and permit proper installation or work.

2. Driveways and Entrances: Keep driveways, parking areas, loading areas, and entrances serving premises clear and available to Owner, public, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.

    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

E. Utilities: Service interruptions of utilities will be allowed for short periods of time per schedule approved by Owner.

1.4 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the Construction Specifications Institute (CSI) "MasterFormat" numbering system.

1. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

Part 2 -- PRODUCTS (NOT USED)

Part 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 25 00 – SUBSTITUTION PROCEDURES

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 01 60 00 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

2. Substitutions for Convenience: Changes proposed by Contractor or Tribe that are not required in order to meet other Project requirements but may offer advantage to Contractor or Tribe.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.

b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Tribe and separate contractors that will be necessary to accommodate proposed substitution.

c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work

specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

e. Samples, where applicable or requested.

f. Certificates and qualification data, where applicable or requested.

g. List of similar installations for completed projects with project names and addresses and names and addresses of Owners.

h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

i. Research reports evidencing compliance with building code in effect for Project.

j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

k. Cost information, including a proposal of change, if any, in the Contract Sum.

l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Owner’s Action: If necessary, Owner will request additional information or documentation for evaluation within seven (7) days of receipt of a request for substitution. Owner will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Change Order, Construction Change Directive, or Owner’s Supplemental Instructions for minor changes in the Work.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

Part 2 -- PRODUCTS

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.

1. Conditions: Owner will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Owner will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

b. Substitution request is fully documented and properly submitted.

c. Requested substitution will not adversely affect Contractor's construction schedule.

d. Requested substitution has received necessary approvals of authorities having jurisdiction.

e. Requested substitution is compatible with other portions of the Work.

f. Requested substitution has been coordinated with other portions of the Work.

g. Requested substitution provides specified warranty.

h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Owner will consider requests for substitution if received within 60 days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of Owner.

1. Conditions: Owner will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Owner will return requests without action, except to record noncompliance with these requirements:

Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Owner for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.

a. Requested substitution does not require extensive revisions to the Contract

Documents.

b. Requested substitution is consistent with the Contract Documents and will produce indicated results.

c. Substitution request is fully documented and properly submitted.

d. Requested substitution will not adversely affect Contractor's construction schedule.

e. Requested substitution has received necessary approvals of authorities having jurisdiction.

f. Requested substitution is compatible with other portions of the Work.

g. Requested substitution has been coordinated with other portions of the Work.

h. Requested substitution provides specified warranty.

i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

Part 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00 – CONTRACT MODIFICATION PROCEDURES

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

B. Related Requirements:

1. Section 01 25 00 - Substitution Procedures for administrative procedures for handling requests for substitutions made after the Contract award.

1.3 MINOR CHANGES IN THE WORK

A. Owner will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.4 PROPOSAL REQUESTS

A. Owner-Initiated Proposal Requests: Owner will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Owner are not instructions either to stop work in progress or to execute the proposed change.

2. Within time specified in Proposal Request or 30 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

c. Include costs of labor and supervision directly attributable to the change.

d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

e. Quotation Form: Use forms acceptable to Owner.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Owner.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Section 01 25 00 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

7. Proposal Request Form: Use form acceptable to Owner.

8. Contractor requests shall be complete and well organized. Incomplete requests may delay the review and/or be cause for rejection without review.

1.5 CHANGE ORDER PROCEDURES

A. On Owner's approval of a Work Changes Proposal Request, Owner will issue a Change Order for signatures of Tribe and Contractor.

Part 2 -- PRODUCTS (NOT USED)

Part 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00 - PAYMENT PROCEDURES

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

B. Related Requirements:

1. Section 01 26 00 "Contract Modification Procedures" for administrative procedures for handling changes to the Contract.

2. Section 01 32 00 "Construction Progress Documentation" for administrative requirements governing the preparation and submittal of the Contractor's construction schedule.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the schedule of values with preparation of Contractor's construction schedule.

1. Coordinate line items in the schedule of values with other required administrative forms and schedules, including the following:

a. Application for Payment forms with continuation sheets.

b. Submittal schedule.

c. Items required to be indicated as separate activities in Contractor's construction schedule.

2. Submit the schedule of values to Owner at earliest possible date, but no later than seven days before the date scheduled for submittal of initial Applications for Payment.

B. Format and Content: Use Project Manual table of contents as a guide to establish line items for the schedule of values. Provide at least one line item for each Specification Section.

1. Identification: Include the following Project identification on the schedule of values:

a. Project name and location.

b. Name of Owner.

c. Owner’s project number.

d. Contractor's name and address.

e. Date of submittal.

2. Arrange schedule of values consistent with format of American Institute of Architects (AIA) Document G703.

3. Arrange the schedule of values in tabular form with separate columns to indicate the following for each item listed:

   a. Related Specification Section or Division.

   b. Description of the Work.

   c. Name of subcontractor.

   d. Name of manufacturer or fabricator.

   e. Name of supplier.

   f. Change Orders (numbers) that affect value.

   g. Dollar value of the following, as a percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.

      1) Labor.

      2) Materials.

      3) Equipment.

4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with Project Manual table of contents. Provide multiple line items for principal subcontract amounts in excess of five percent of the Contract Sum.

   a. Include separate line items under Contractor and principal subcontracts for Project closeout requirements in an amount totaling five percent of the Contract Sum and subcontract amount.

5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.

6. Provide a separate line item in the schedule of values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.

a. Differentiate between items stored on-site and items stored off-site. If required, include evidence of insurance.

7. Provide separate line items in the schedule of values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.

8. Each item in the schedule of values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.

   a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the schedule of values or distributed as general overhead expense, at Contractor's option.

1.5 APPLICATIONS FOR PAYMENT

A. Follow guidance in the master contract with the Tribe for requesting payment.

Part 2 -- PRODUCTS (NOT USED)

Part 3 -- EXECUTION (NOT USED)

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SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.

2. Requests for Information (RFIs).

3. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:

1. Section 01 32 00 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.

2. Section 01 73 00 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.

3. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.

1.3 DEFINITIONS

A. RFI: Request from Owner or Contractor seeking information required by or clarifications of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Contractor shall submit a list of proposed subcontractors and the work to be performed by each.

B. Key Personnel Names: Within 14 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and telephone numbers, including home, office, and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections, that depend on each other for proper installation, connection, and operation.

   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.

   2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.

   3. Make adequate provisions to accommodate items scheduled for later installation.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1.6 REQUESTS FOR INFORMATION (RFIS)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

   1. Owner will return RFIs submitted by other entities controlled by Contractor with no response.

   2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

   3. RFI’s shall not be used to propose substitutions or modifications to the Work. Contractor Modifications shall be submitted as defined in Section 01 26 00 – Contract Modification Procedures.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

   1. Project name.

   2. Project number.

   3. Date.

   4. Name of Contractor.

   5. Name of Owner.

6. RFI number, numbered sequentially.

7. RFI subject.

8. Specification Section number and title and related paragraphs, as appropriate.

9. Drawing number and detail references, as appropriate.

10. Field dimensions and conditions, as appropriate.

11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.

12. Contractor's signature.

13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: Form with substantially the same content as indicated above, acceptable to Owner.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Owner's Action: Owner will review each RFI, determine action required, and respond. Allow seven working days for Owner's response for each RFI. RFIs received by Owner after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.

    b. Requests for approval of substitutions.

    c. Requests for approval of Contractor's means and methods.

    d. Requests for coordination information already indicated in the Contract Documents.

    e. Requests for adjustments in the Contract Time or the Contract Sum.

    f. Requests for interpretation of Owner's actions on submittals.

    g. Incomplete RFIs or inaccurately prepared RFIs.

2. Owner's action may include a request for additional information, in which case Owner's time for response will date from time of receipt of additional information.

3. Owner's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 01 26 00 "Contract Modification Procedures."

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Owner in writing within 10 days of receipt of the RFI response.

E. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Include the following:

1. Project name.

2. Name and address of Contractor.

3. Name and address of Owner.

4. RFI number including RFIs that were returned without action or withdrawn.

5. RFI description.

6. Date the RFI was submitted.

7. Date Owner's response was received.

F. On receipt of Owner's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Owner within seven days if Contractor disagrees with response.

1. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.

1.7 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site in a Contractor-provided meeting space unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Owner of scheduled meeting dates and times.

2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.

3. Minutes: Entity responsible for conducting meeting will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner, within three days of the meeting.

B. Preconstruction Conference: Schedule and conduct a preconstruction conference before starting construction, at a time convenient to Owner, but no later than 15 days after execution of the Agreement.

1. Conduct the conference to review responsibilities and personnel assignments.

2. Attendees: Authorized representatives of Owner and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect progress, including the following:

    a. Tentative construction schedule.
    b. Phasing.
    c. Critical work sequencing and long-lead items.
    d. Designation of key personnel and their duties.
    e. Lines of communications.
    f. Procedures for processing field decisions and Change Orders.
    g. Procedures for RFIs.
    h. Procedures for testing and inspecting.
    i. Procedures for processing Applications for Payment.
    j. Distribution of the Contract Documents.
    k. Submittal procedures.
    l. Preparation of record documents.
    m. Use of the premises.
    n. Work restrictions.
    o. Working hours.
    p. Responsibility for temporary facilities and controls.
    q. Procedures for disruptions and shutdowns.
    r. Parking availability.
    s. Office, work, and storage areas.
    t. Equipment deliveries and priorities.
    u. Safety requirements.
    v. First aid.
    w. Security.
    x. Labor laws.

4. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. Pre-installation Conferences: Conduct a pre-installation conference at Project site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise Owner of scheduled meeting dates.

2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.

f. Deliveries.
g. Submittals.
h. Sustainable design requirements.
i. Review of mockups.
j. Possible conflicts.
k. Compatibility requirements.
l. Time schedules.
m. Weather limitations.
n. Manufacturer's written instructions.
o. Warranty requirements.
p. Compatibility of materials.
q. Acceptability of substrates.
r. Temporary facilities and controls.
s. Space and access limitations.
t. Regulations of authorities having jurisdiction.
u. Testing and inspecting requirements.
v. Installation procedures.
w. Coordination with other work.
x. Required performance results.
y. Protection of adjacent work.
z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.

5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

D. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Owner, but no later than 90 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.

2. Attendees: Authorized representatives of Owner and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of record documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Submittal of written warranties.

d. Requirements for completing sustainable design documentation.
e. Requirements for preparing operations and maintenance data.
f. Requirements for delivery of material samples, attic stock, and spare parts.
g. Requirements for demonstration
h. + and training.
i. Preparation of Contractor's punch list.
j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
k. Submittal procedures.
l. Coordination of separate contracts.
m. Owner's partial occupancy requirements.
n. Installation of Owner's furniture, fixtures, and equipment.
o. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

E. Progress Meetings: Conduct progress meetings at biweekly intervals.

1. Coordinate dates of meetings with preparation of payment requests.

2. Attendees: In addition to representatives of Owner, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

1) Review schedule for next period.

b. Review present and future needs of each entity present, including the following:

1) Interface requirements.
2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site utilization.
8) Temporary facilities and controls.
9) Progress cleaning.
10) Quality and work standards.

11) Status of correction of deficient items.
12) Field observations
13) Status of RFIs.
14) Status of proposal requests.
15) Pending changes.
16) Status of Change Orders.
17) Pending claims and disputes.
18) Documentation of information for payment requests.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

   a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

Part 2 -- PRODUCTS (NOT USED)

Part 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's construction schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Material location reports.
6. Site condition reports.
7. Special reports.

B. Related Requirements:

1. Section 01 33 00 "Contractor Submittals" for submitting schedules and reports.

2. Section 01 40 00 "Quality Requirements" for submitting a schedule of tests and inspections.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.

2. Predecessor Activity: An activity that precedes another activity in the network.

3. Successor Activity: An activity that follows another activity in the network.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.

2. PDF electronic file.

B. Contractor's Construction Schedule: Initial schedule, of size required to display entire

schedule for entire construction period.

C. Construction Schedule Updating Reports: Submit with Applications for Payment.

D. Daily Construction Reports: Submit at monthly intervals.

E. Site Condition Reports: Submit at time of discovery of differing conditions.

F. Special Reports: Submit at time of unusual event.

G. Qualification Data: For scheduling consultant.

1.5 COORDINATION

A. Coordinate Contractor's construction schedule with the schedule of values, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.

2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

Part 2 -- PRODUCTS

2.1 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Time Frame: Extend schedule from date established for commencement of the Work to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each story or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Startup and Testing Time: Include no fewer than 15 days for startup and testing.

2. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Owner’s administrative procedures necessary for certification of Substantial Completion.

3. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

4. Indicate long-lead items that can disrupt major portions of work if not ordered in time.

C. Milestones: Include milestones indicated in the Contract Documents in schedule, including,

but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

D. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules

2.2 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Accidents.
8. Meetings and significant decisions.
9. Unusual events (see special reports).
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

2.3 SPECIAL REPORTS

A. General: Submit special reports directly to Owner within one day of an occurrence. Distribute copies of report to parties affected by the occurrence.

B. Reporting Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise Owner in advance when these

events are known or predictable.

Part 3 -- EXECUTION

3.1 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Contractor's Construction Schedule Updating: At bi-weekly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

B. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.

1. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.

2. As the Work progresses, indicate final completion percentage for each activity.

C. Distribution: Distribute copies of approved schedule to Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

END OF SECTION

SECTION 01 33 00 – CONTRACTOR SUBMITTALS

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Requirements:

1. Section 01 29 00 "Payment Procedures" for submitting Applications for Payment and the schedule of values.

2. Section 01 32 00 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.

3. Section 01 77 00 "Closeout Procedures" for submitting technical manuals.

4. Section 01 78 39 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Owner’s responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Owner’s responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.4 ACTION SUBMITTALS

A. Schedule: Submit a schedule of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making

corrections or revisions to submittals noted by Owner and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.

2. Initial Submittal: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.

3. Final Submittal: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Submit revised submittal schedule to reflect changes in current status and timing for submittals.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Owner’s final release or approval.
    g. Scheduled date of fabrication.
    h. Scheduled dates for purchasing.
    i. Scheduled dates for installation.
    j. Activity or event number.

1.5 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Owner’s Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Owner for Contractor's use in preparing submittals.

1. Owner will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

    a. Owner makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

    a. Owner reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Owner's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 work days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Owner will advise Contractor when a submittal being processed must be delayed for coordination.

2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.

3. Resubmittal Review: Allow 15 work days for review of each resubmittal.

4. Sequential Review: Where sequential review of submittals by Owner's consultants, Owner, or other parties is indicated, allow 20 work days for initial review of each submittal.

D. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.

2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., BCH-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., BCH-061000.01.A).

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Owner.

4. Transmittal Form for Electronic Submittals: Use electronic form acceptable to Owner, containing the following information:

    a. Project name.
    b. Date.
    c. Name and address of Owner.
    d. Name of Construction Manager.
    e. Name of Contractor.
    f. Name of firm or entity that prepared submittal.
    g. Names of subcontractor, manufacturer, and supplier.

h. Category and type of submittal.
i. Submittal purpose and description.
j. Specification Section number and title.
k. Specification paragraph number or drawing designation and generic name for each of multiple items.
l. Drawing number and detail references, as appropriate.
m. Location(s) where product is to be installed, as appropriate.
n. Related physical samples submitted directly.
o. Indication of full or partial submittal.
p. Transmittal number, numbered consecutively.
q. Submittal and transmittal distribution record.
r. Other necessary identification.
s. Remarks.

E. Options: Identify options requiring selection by Owner.

F. Deviations and Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Owner on previous submittals, and deviations from requirements in the Contract Documents, including minor variations and limitations. Include same identification information as related submittal. Ensure the Owner is included on all deviation requests. This is to ensure that the contract is not substantially changed.

G. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.

2. Note date and content of revision in label or title block and clearly indicate extent of revision.

3. Resubmit submittals until they are marked as either “No Exceptions Taken” or “Make Corrections Noted” from Owner’s action stamp. The Contractor shall not proceed with construction of submitted items until marked as either “No Exceptions Taken” or “Make Corrections Noted”.

H. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

I. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Owner’s action stamp.

Part 2 -- PRODUCTS

2.1 SUBMITTAL PROCEDURES

A. General Submittal Procedure Requirements: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Submit electronic submittals via Submittal Exchange as PDF electronic files.

a. Owner will return annotated file. Annotate and retain one copy of file as an electronic Project record document file.

2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a notarized statement on original paper copy certificates and certifications where indicated.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's product specifications.
c. Standard color charts.
d. Statement of compliance with specified referenced standards.
e. Testing by recognized testing agency.
f. Application of testing agency labels and seals.
g. Notation of coordination requirements.
h. Availability and delivery time information.

4. Submit Product Data before or concurrent with Samples.

5. Submit Product Data in the following format:

a. PDF electronic file.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches, but no larger than 30 by 42 inches.

3. Submit Shop Drawings in the following format:

    a. PDF electronic file.

D. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.

2. Identification: Attach label on unexposed side of Samples that includes the following:

    a. Generic description of Sample.

    b. Product name and name of manufacturer.

    c. Sample source.

    d. Number and title of applicable Specification Section.

    e. Specification paragraph number and generic name of each item.

3. For projects where electronic submittals are required, provide corresponding electronic submittal of Sample transmittal, digital image file illustrating Sample characteristics, and identification information for record.

4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Owner will return submittal with options selected.

E. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."

F. Application for Payment and Schedule of Values: Comply with requirements specified in Section 01 29 00 "Payment Procedures."

G. Test and Inspection Reports and Schedule of Tests and Inspections Submittals: Comply with requirements specified in Section 01 40 00 “Quality Requirements.”

H. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Section 01 77 00 "Closeout Procedures."

I. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and

addresses, contact information of Owner, and other information specified.

J. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

K. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.

L. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.

M. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.

N. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.

O. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.

P. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

Q. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

R. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.

S. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate

preparation needed for adhesion.

Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

T. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

2.2 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Owner.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file and three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

Part 3 -- EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Action and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Review each submittal, including those from Contractor’s suppliers and Subcontractors, for accuracy, organization, and completeness prior to submitting to the Owner for review. Complete, organized and well annotated submittals will help expedite the review process. Note corrections and field dimensions. Mark with approval stamp before submitting to Owner.

B. Project Closeout and Maintenance Material Submittals: See requirements in Section 01 77 00 “Closeout Procedures.”

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 OWNER'S ACTION

A. Action Submittals: Owner will review each submittal, make marks to indicate corrections or revisions required, and return it. Owner will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.

B. Informational Submittals: Owner will review each submittal and will not return it, or will return it if it does not comply with requirements. Owner will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Owner.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Submittals not required by the Contract Documents may be returned by the Engineer without action.

END OF SECTION

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SECTION 01 40 00 – QUALITY REQUIREMENTS

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.

2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.

3. Requirements for Contractor to provide quality-assurance and -control services required by Owner or authorities having jurisdiction are not limited by provisions of this Section.

4. Specific test and inspection requirements are not specified in this Section.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

C. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

D. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction to establish product performance and compliance with specified requirements.

E. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

F. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Engineer for a decision before proceeding.

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

1.5 INFORMATIONAL SUBMITTALS

A. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

1.6 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Owner’s records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient

production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

F. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.

2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

G. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f. When testing is complete, remove test specimens, and assemblies; do not reuse products on Project. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report

whether tested and inspected work complies with or deviates from the Contract Documents.

1.8 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.

2. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.

3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.

4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.

5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 01 33 00 "Contractor Submittals."

Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in pre-installation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of

completed portions of the Work, and submittal of written reports.

D. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
6. Security and protection for samples and for testing and inspecting equipment at Project site.

F. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.9 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Conducted by a qualified testing agency as required by authorities having jurisdiction, as indicated in individual Specification Sections.

1. Notifying Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
2. Submitting a certified written report of each test, inspection, and similar quality-control service to Engineer with copy to Contractor and to authorities having jurisdiction.
3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
5. Retesting and re-inspecting corrected work.
6. PRODUCTS (Not Used)

Part 2 -- EXECUTION

2.1 TEST AND INSPECTION LOG

1. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

2. Date test or inspection was conducted.

3. Description of the Work tested or inspected.

4. Date test or inspection results were transmitted to Engineer.

5. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

2.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 01 73 00 - Execution.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION

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SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements:

1. Section 01 10 00 "Summary" for work restrictions and limitations on utility interruptions.

1.3 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Engineer, testing agencies, and authorities having jurisdiction.

B. Water Service: Owner will pay water-service use charges for water used by all entities for construction operations.

C. Electric Power Service: Owner will pay electric-power-service use charges for electricity used by all entities for construction operations.

1.4 INFORMATIONAL SUBMITTALS

A. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

B. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously

assigned responsibilities.

Part 2 -- PRODUCTS

2.1 MATERIALS

A. Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top rails.

B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch-thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

Part 3 -- EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance as specified in Section 01 10 00 "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Water Service: Use existing.

C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

D. Electric Power Service: Use existing.

3.3 SUPPORT FACILITIES INSTALLATION

A. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.

2. Maintain access for fire-fighting equipment and access to fire hydrants.

B. Parking: Provide temporary parking areas for construction personnel.

C. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.

D. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.

2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touchup signs so they are legible at all times.

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 01 73 00 "Execution."

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Section 01 10 00 "Summary."

B. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to requirements of 2003 EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

C. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

D. Tree and Plant Protection: Install temporary fencing located outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

E. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.

3.5 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard, replace, or clean stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Use permanent HVAC system to control humidity.

3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

    a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.

    b. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to Engineer.

    c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

END OF SECTION

SECTION 01 60 00 – PRODUCT REQUIREMENTS

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

B. Related Requirements:

1. Section 01 25 00 "Substitution Procedures" for requests for substitutions.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.

2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

3. Comparable Product: A substitution product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Basis-of-Design Product Specification: A specification in which a specific manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.4 ACTION SUBMITTALS

A. Comparable Product Requests: Submit a substitution request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

B. Include data to indicate compliance with the requirements specified in "Comparable Products" Article herein, and the requirements of Section 01 25 00 – Substitution Procedures.

1. Owner's Action: If necessary, Owner will request additional information or documentation for evaluation within one week of receipt of a comparable product request. Owner will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Form of Approval: As specified in Section 01 33 00 "Contractor Submittals."

b. Use product specified if Owner does not issue a decision on use of a comparable product request within time allocated.

C. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01 33 00 "Contractor Submittals." Show compliance with requirements.

1.5 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.

2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.

4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.

5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

6. Protect stored products from damage and liquids from freezing.

1.7 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.

2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.

3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 01 77 00 "Closeout Procedures."

Part 2 -- PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," Owner will make selection.

5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.

B. Product Selection Procedures:

1. Products:

a. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

2. Manufacturers:

a. Nonrestricted List: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed manufacturer's product.

3. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration: Owner will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Owner may return requests without action, except to record noncompliance with these requirements:

1. Requested substitution is consistent with the Contract Documents and will produce indicated results.

2. Substitution request is fully documented and properly submitted.

3. Requested substitution will not adversely affect Contractor's construction schedule.

4. Requested substitution has received necessary approvals of authorities having jurisdiction.

5. Requested substitution is compatible with other portions of the Work.

6. Requested substitution has been coordinated with other portions of the Work.

7. Requested substitution provides specified warranty.

8. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

Part 3 -- EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 71 00 – MOBILIZATION

PART 1 - GENERAL

1.1 THE SUMMARY

A. CONTRACTOR shall mobilize as required for the proper performance and completion of the WORK and in accordance with the Contract Documents.

B. Mobilization shall include at least the following items:

1. Installing temporary construction power, wiring, and lighting facilities complying with Section 01 50 00 “Temporary Facilities and Controls.”

2. Developing construction water supply.

3. Providing field offices for the CONTRACTOR and meeting space for the CONTRACTOR, OWNER, and ENGINEER, complete with furnishings, equipment, and utility services.

4. Providing on-Site communication facilities, including telephones and internet.

5. Providing on-Site sanitary facilities and potable water facilities.

6. Arranging for and erection of CONTRACTOR's WORK and storage yards.

7. Constructing and implementing security features and requirements complying with Section 01 50 00 - Temporary Facilities and Controls.

8. Having OSHA required notices and establishing safety programs.

9. Submitting initial submittals.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 73 00 – EXECUTION

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.

B. Related Requirements:

1. Section 01 10 00 "Summary" for limits on use of Project site.
2. Section 01 33 00 "Contractor Submittals" for submitting surveys.
3. Section 01 77 00 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor.

B. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written

recommendations and instructions for installation of products and equipment.

Part 2 -- PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

Part 3 -- EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.

2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work.

2. List of detrimental conditions, including substrates.

3. List of unacceptable installation tolerances.

4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having

jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Owner according to requirements in Section 01 31 00 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Owner promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Owner when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Owner.

3.4 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks

and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Owner. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Owner before proceeding.

2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.

3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level, except pipes that are indicated to be sloped.

2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.

3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

4. Maintain minimum headroom clearance of 96 inches in occupied spaces and 90 inches in unoccupied spaces. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

B. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

C. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

D. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to the parties involved templates for work specified to be

factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Owner.

2. Allow for building movement, including thermal expansion and contraction.

3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.

2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F.

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.

2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.

H. Roads: When there is a visible track-out onto a paved public road, install wheel washers where the vehicles exit and enter onto the paved roads and wash the undercarriage of truck and any equipment leaving the Site on each trip. Sweep the paved street at the end of each shift with a **Mobile Athey** or similar water spray pick-up broom-type street sweeper as necessary or as directed.

I. During performance of the WORK, the CONTRACTOR shall perform maintenance including snow removal to maintain access to the project areas of WORK as necessary.

J. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.1 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer's Field Service: Comply with qualification requirements in Section 01 40 00 - Quality Requirements.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION

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SECTION 01 74 20 - GRAVITY PIPELINE TESTING

PART 1 - GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall test drain system pipelines, manholes, and standpipes in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Furnish:

1. A testing plan and schedule including sequence and methods for water conveyance, control, leak testing, and water disposal shall be submitted in writing for approval.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Gravity pipes and laterals shall be tested for exfiltration or infiltration as indicated. Manholes shall be tested for leakage prior to backfill placement, whereas pipes shall be backfilled prior to testing. The maximum length of pipe tested shall be the 4 reaches between 5 manholes. Leakage tests shall be completed and approved prior to placing of permanent resurfacing of pavement. When leakage or infiltration exceeds the allowed amount, the CONTRACTOR shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the allowable limits. Individually detectable leaks shall be repaired, regardless of whether the test results are acceptable or not.

B. Unless otherwise indicated, water for testing will be furnished by the OWNER; however, the CONTRACTOR shall convey the water from the OWNER-designated source to the points of use.

C. No materials shall be used which would be injurious to pipeline structure and future function. Air test gauges shall be laboratory-calibrated test gauges, and if required by the ENGINEER, shall be recalibrated by a certified laboratory prior to the leakage test. Air test gauges shall have a size and pressure range appropriate for the pipe being tested.

D. Testing operations shall be performed in the presence of the ENGINEER.

3.2 TESTING SCHEDULE

A. Leakage Tests

1. Perform the type of leakage tests determined from the table below, based on pipe size, slope between manholes (Criterion 1), and difference in water levels (Criterion 2).

	CRITERION 1		CRITERION 2	
NOMINAL PIPE SIZE	**MANHOLE DELTA H, FEET**		**TEST WATER VS GROUND WATER DELTA H, FEET**	
	Less than or equal to10 ft	greater than 10 ft	greater than or equal to 4 ft	less than 4 ft
less than or equal to 24 inches	See Criterion 2	Infiltration or Air See Note 1	Exfiltration	Infiltration or Air
greater than 24 inches	See Criterion 2	See Criterion 2	Exfiltration	Infiltration

Note 1. If ground water is present, perform an infiltration test or air test at the option of the CONTRACTOR; if no ground water is present, perform an air test.

2. Definitions

   a. Delta H is the difference between 2 elevations, expressed in feet.

   b. Manhole Delta H is the invert elevation difference in 2 adjacent manholes.

   c. Test Water vs Ground Water Delta H is the required elevation of water surface for testing minus the average elevation of ground water adjacent to the pipe to be tested. Units are feet.

3.3 WATER EXFILTRATION TEST

A. Each section of pipe shall be tested between by closing downstream end with stoppers or inflatable plugs. The pipe shall be filled with water to a point 4-feet above the highpoint of the pipe.

B. Water shall remain in the pipe for at least one hour or until the water level stabilizes, whichever is longer, before the test begins. The minimum test duration shall be 4 hours.

C. Unless indicated otherwise, the CONTRACTOR shall measure exfiltration. Measure the amount of water added to the upstream end of the pipe to maintain the water level at the elevation set above. Compare the amount added to the allowable leakage calculated below, and if the amount added is equal to or less than the allowable amount, the tested section of the pipe has passed.

D. The allowable leakage will be computed by the formula:

$$E = 0.000012\ LD\ (H)^{1/2}$$

Where:

E = Allowable leakage in gallons per minute of sewer tested.

L = Length of sewer and house connections tested, in feet.

D = Internal diameter of the pipe in inches.

H=Elevation difference in feet between the water surface in the upper manhole and the centerline of the pipe at the lower manhole; or if ground water is present above the centerline of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

3.4 WATER INFILTRATION TEST

A. The end of the pipe at the upper structure shall be closed to prevent the entrance of water, and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

B. The infiltration into each individual reach of pipe between adjoining structures or manholes shall not exceed that allowed by the formula above, where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole.

C. Unless otherwise indicated, infiltration shall be measured by the CONTRACTOR.

3.5 AIR PRESSURE TEST

A. The CONTRACTOR shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the ENGINEER.

B. The CONTRACTOR may conduct an initial air test of the pipe after densification of the backfill but prior to installation of any laterals. Such tests will be considered to be for the CONTRACTOR's convenience and need not be performed in the presence of the ENGINEER.

C. Each section of pipe shall be tested between successive manholes by plugging and bracing all openings in the pipe and the upper ends of all laterals. Prior to insertion in the pipe, each plug shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released and the leaks eliminated or the plug replaced.

D. The test of the pipe and laterals shall be conducted in the presence of the ENGINEER. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM F 1417 - Standard Test Method for Installation of Plastic Gravity Sewer Line Using Low Pressure Air.

E. Air pressure shall be increased to 4.0 psi above groundwater pressure (1.0 psi for each 2.3 feet of water elevation above the highest point of the pipe). Do not allow the pressure at any point in the pipe to reach 9 psi under any circumstances. Allow the pressure to stabilize for

5 minutes, then reduce the pressure to 3.5 psi above groundwater pressure and start the test. Stop the air release and record the decrease in pressure over time.

F. Pass/Fail Criterion: The time taken for the pressure to decrease from 3.5 to 2.5 psi above groundwater pressure shall be equal to or greater than the time below.

Nominal Pipe Diameter, inches	Minimum Time, min:sec	Length for Minimum Time, ft	Increased Time for Longer Lengths, seconds per foot
4	3:46	597	.0380
6	5:40	398	0.854
8	7:34	298	1.520
10	9:26	239	2.374
12	11:20	199	3.418
18	17:00	133	7.692
24	22:40	99	13.674

G. Testing criteria of pipe 12-inches and larger may be adjusted if the ENGINEER approves. The air pressure decrease may be 0.5 psi instead of 1.0 psi, and the corresponding minimum times will be one-half of the tablulated times.

H. If the time is less than the allowable time, the pipe will be considered defective and shall be repaired and retested.

3.6 MANHOLE TEST

A. Hydrostatic Testing: All pipes entering the manhole shall be sealed at a point outside the manhole walls to include testing of the pipe to manhole joints. The manhole shall be filled with water to a level 2-inches below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least one hour to allow the water level to stabilize, the manhole shall be refilled and the water level shall be marked. The water level shall again be checked after 4 hours. If the water level falls more than 1-inch, the leakage shall be considered excessive, and the CONTRACTOR shall make repairs and retest the manhole. The exterior of the manhole shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the ENGINEER regardless of the volume of water lost.

B. Vacuum Testing

1. Install the vacuum test head on top of the manhole. Install and brace sealing devices on influent and effluent pipes

2. With a vacuum pump, draw a vacuum of 10 inches of mercury, deactivate the pump, and measure the time in seconds for the vacuum to drop to 9 inches of mercury.

3. Compare the time to the table below.

Minimum Time, min: sec				
Manhole Depth, ft	**Manhole Diameter, inches**			
	36	48	60	72
8	0:14	0:20	0:26	0:33
10	0:18	0:25	0:33	0:41
12	0:21	0:30	0:39	0:49
14	0:25	0:35	0:48	0:57
16	0:28	0:40	0:52	1:7
18	0:32	0:45	0:59	1:13

4. If the time is less than the time in the table, the manhole is defective, and it shall be repaired and retested until it is acceptable.

END OF SECTION

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SECTION 01 74 30 - PRESSURE PIPE TESTING

PART 1 - GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall test water pipelines and appurtenant piping, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Furnish:

1. A testing plan and schedule, including sequence and method for water conveyance, control, and disposal shall be submitted in writing for approval.

PART 2 - PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. All test equipment, temporary valves, bulkheads, and other water control equipment shall be as determined by the CONTRACTOR. No materials shall be used which would be injurious to the WORK.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate with the OWNER to locate a suitable water source for testing water pipelines. The CONTRACTOR shall provide any temporary piping necessary to convey water from the OWNER-designated source to the points of use.

B. All new pipelines shall be tested.

3.2 HYDROSTATIC TESTING OF PIPELINES

A. Prior to hydrostatic testing, pipelines shall be flushed or blown out as appropriate. The CONTRACTOR shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline. Where such valves are not present, the CONTRACTOR shall install temporary bulkheads or plugs for the purpose of testing. Sections that have a zero leakage allowance may be tested as a unit. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 Days. The test shall be made by closing valves when available or by placing bulkheads and filling the line slowly with water. The CONTRACTOR shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment. Remove or protect any pipeline-mounted devices that may be damaged by the test pressure. The CONTRACTOR shall provide sufficient temporary tappings in the pipelines to allow for trapped air to exit. After completion of the tests, such

taps shall be permanently plugged. Care shall be taken that air relief valves are open during filling.

B. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the release valves at a reasonable velocity. The air within the pipeline shall be allowed to escape completely. The differential pressure across the orifices in the air release valves shall not be allowed to exceed 5 psi at any time during filling. After the pipeline or section thereof has been filled, it shall be allowed to stand under a slight pressure for at least 24 hours to allow the concrete or mortar lining, as applicable, to absorb water and to allow the escape of air from air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.

C. The hydrostatic test shall consist of holding the indicated test pressure on the pipeline segment for a period of 4 hours. The test pressure for buried piping shall be 50 psi, measured at the lowest point of the pipeline section being tested. Visible leaks that appear during testing shall be repaired in a manner acceptable to the ENGINEER. Add water to restore the test pressure if the pressure decreases 5 psi below test pressure during the test period.

D. The maximum leakage for buried piping shall be be 0.02 U.S. gallons per hour per inch of diameter per 100 feet of pipe. Exposed piping shall show no visible leaks and no pressure loss during the test. In the case of pipelines that fail to pass the leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

END OF SECTION

SECTION 01 77 00 – CLOSEOUT PROCEDURES

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 01 73 00 - Execution for progress cleaning of Project site.
2. Section 01 78 39 - Project Record Documents for submitting record Drawings, record Specifications, and record Product Data.

1.3 ACTION SUBMITTALS

A. Product Data: For cleaning agents.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.4 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

1.5 TECHNICAL AND OPERATION AND MAINTENANCE (O&M) MANUAL SUBMITTALS

A. Schedule of technical and Operations and Maintenance Material Items: For maintenance material submittal items specified in other Sections.

B. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.

C. The manual shall be written such that it can be used and understood by the OWNER's operation and maintenance staff. Each manual shall be customized to this project and

specific equipment and all options shall be marked as provided or lined out as not provided.

D. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Part." The following " Parts" shall be addressed (as applicable):

   a. Part 1 - Equipment Summary

      1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

      2) Form: The ENGINEER will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the WORK. The CONTRACTOR shall fill in the relevant information on the form and include it in Part 1.

   b. Part 2 - Operational Procedures

      1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

         Installation
         Adjustment
         Startup
         Location of controls, special tools, equipment required,
         or related instrumentation needed for operation
         Operation procedures
         Load changes
         Calibration
         Shutdown
         Troubleshooting
         Disassembly
         Reassembly
         Realignment
         Testing to determine performance efficiency
         Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices
         List of all electrical relay settings including alarm and contact settings

   c. Part 3 - Preventive Maintenance Procedures

      1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

      2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

d. Part 4 - Parts List

1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

e. Part 5 - Wiring Diagrams

1) Diagrams: Part 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

f. Part 6 - Shop Drawings

1) Drawings: This Part includes approved shop or fabrication drawings with ENGINEER comments and corrections incorporated, complete with dimensions.

g. Part 7 - Safety

1) Procedures: This Part describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Part 8 - Documentation:

1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this Part.

E. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, OWNER's project number, Specification Section number, equipment name, and equipment identification number. Binder shall be 3" white or black with back mounted ring with gap free locking ring, Avery 68041, or equal.

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders/Volumes in a multi-binder set. Each binder shall be identified as a Volume clearly labeled on the cover and at the Top or bottom on the spline with vertical text when standing on a shelf. The order of sections shall be by Specification number. Table of content and sections shall be identified first by Specification number, Item Name and the by equipment Tag number (if applicable).

3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 inch by 11 inch shall be folded to 8-1/2 inch by 11 inch size. Color copies shall be provided of colored contents.

4. Provide a CD with electronic files with each final set of Technical Manuals, as follows:

a. Project-specific files created in Microsoft Office, latest version;

b. AutoCad, latest version;

c. Portable Document Format (PDF) or other software required by the Specifications; and,

d. Manufacturer literature in Adobe Acrobat portable document format (PDF).

F. Submittal and Review Process

1. Draft Technical Manuals: Draft submittal(s) may be submitted may be submitted separately by complete section, Volume, or full set with all Volumes. Each Draft submittal shall be submitted as a separate submittal. If a resubmittal is necessary, all resubmittals up to the Final Draft Submittal shall be resubmitted under the same submittal number with different resubmittal number. Draft submittals shall be submitted in pdf format with all parts included in a single file organized for direct printing with divider pages between sections, cover, table of contents, etc. Where information is not final at the time of the Draft submittal representative/sample pages shall be included indicating what information will be provided, and those pages shall be clearly marked PLACEHOLDER. Every Draft submittal shall include the complete Table of contents for all volumes and the detailed table of content for the submitted document.

2. Final Draft Technical Manual: Final Draft submittal shall be complete with all Volumes and sections complete except for those items to be replaced with as-built or post startup certifications. Where information is not final at the time of the Final Draft Technical Manual submittal representative/sample pages shall be included indicating what information will be provided, and those pages shall be clearly marked PLACEHOLDER. The Final Draft Technical Manual submittal shall be complete in every way except for the final material to be inserted. The submittal shall include 2- DVD's containing the complete set organized by Volume and one complete hard copy set.

3. Final Technical Manual: Incorporate comments from the Final Draft and submit 1 hard-copy set of the final manual for acceptance and 3-DVD electronic copies.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items

below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.

3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit test/adjust/balance records.

5. Submit sustainable design submittals not previously submitted.

6. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.

B. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Advise Owner of changeover in heat and other utilities.

6. Participate with Owner in conducting inspection and walkthrough with local emergency responders.

7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

8. Complete final cleaning requirements, including touchup painting.

9. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

10. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Owner will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Owner, that must be completed or corrected before certificate will be issued.

11. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

12. Results of completed inspection will form the basis of requirements for final completion.

1.8 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 01 29 00 "Payment Procedures."

2. Certified List of Incomplete Items: Submit certified copy of Owner's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Owner. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Owner will either proceed with inspection or notify Contractor of unfulfilled requirements. Owner will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first.

2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.

3. Include the following information at the top of each page:

4. Project name.

    a. Date.

    b. Name of Owner.

    c. Name of Contractor.

    d. Page number.

5. Submit list of incomplete items in the following format:

    a. MS Excel electronic file. Owner will return annotated file.

1.10 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Owner for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2 by 11 inch paper.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty to include in operation and maintenance manuals.

Part 2 -- PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

B. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC

levels.

Part 3 -- EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

d. Remove tools, construction equipment, machinery, and surplus material from Project site.

e. Remove debris and surface dust from limited access spaces, including trenches, equipment vaults, manholes, and similar spaces.

f. Remove labels that are not permanent.

g. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

h. Leave Project clean and ready for occupancy.

C. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 74 19 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or

restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.

2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

END OF SECTION

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SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

Part 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 01 73 00 "Execution" for final property survey.
2. Section 01 77 00 "Closeout Procedures" for general closeout procedures.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of record Drawings as follows:

a. Initial Submittal:

1) Submit PDF electronic files of scanned record prints and one of file prints.

2) Owner will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:

1) Submit PDF electronic files of scanned record prints and three set(s) of prints.

B. Record Specifications: Submit annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

Part 2 -- PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Locations and depths of underground utilities.
d. Revisions to routing of piping and conduits.
e. Revisions to electrical circuitry.
f. Actual equipment locations.
g. Duct size and routing.
h. Changes made by Change Order or Construction Change Directive.
i. Changes made following Owner's written orders.
j. Details not on the original Contract Drawings.
k. Field records for variable and concealed conditions.
l. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.

4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2. Format: Annotated PDF electronic file with comment function enabled.

3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.

4. Identification: As follows:

   a. Project name.

   b. Date.

   c. Designation "PROJECT RECORD DRAWINGS."

   d. Name of Owner.

   e. Name of Contractor.

2.2 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

   2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

   3. Note related Change Orders and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file.

Part 3 -- EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project

record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Owner's reference during normal working hours.

END OF SECTION

SECTION 02 41 19 - DEMOLITION AND RECONSTRUCTION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall demolish and reconstruct existing civil, structural, mechanical, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.2 COORDINATION

A. The CONTRACTOR shall note that the Drawings indicating demolition are based on a ground survey of the existing facilities. Prior to Bidding, the CONTRACTOR shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of WORK, and the extent of auxiliary utilities.

B. While demolition is being performed, the CONTRACTOR shall provide protection of the CONTRACTOR's employees and the OWNER's personnel. The CONTRACTOR shall remove such protection when reconstruction activities are complete, or as WORK progresses, or when requested by the ENGINEER.

1.3 CONTRACTOR SUBMITTALS

A. Demolition activities and procedures, including operational sequences, shall be submitted to the ENGINEER for approval. The procedures shall provide for safe conduct of the WORK, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation.

1.4 DEMOLITION

A. Existing pavement, structures, equipment, piping, valves, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the WORK shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the CONTRACTOR.

B. Items to be removed include:

Item	Description
Chain Link Fencing	Existing chain link fencing and gates
Electrical Equipment	Transformer and panels enclosed by chainlink in the southeast part of the site

1.5 ABANDONMENT

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances to be abandoned shall be prepared by the CONTRACTOR as indicated.

1.6 REHABILITATION

A. Existing civil and landscaping WORK disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged surfaces shall be restored to a condition equal to and matching that existing prior to damage.

1.7 DISPOSAL

A. The CONTRACTOR shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall coordinate demolition WORK with the OWNER and ENGINEER. Unless otherwise indicated, the CONTRACTOR shall be responsible for the sequence of activities. WORK shall be performed in accordance with applicable safety rules and regulations.

B. The CONTRACTOR shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

C. The CONTRACTOR shall take precautions to avoid damage to adjacent facilities and to limit the WORK activities to the extent indicated. If reconstruction beyond the scope indicated is required, the CONTRACTOR shall obtain approval from the ENGINEER prior to commencing.

D. Persons shall be afforded safe passages around areas of demolition.

E. Structural elements shall not be overloaded. The CONTRACTOR shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of WORK performed under this Section. The CONTRACTOR shall remove temporary protection when the WORK is complete or when so authorized by the ENGINEER.

F. The CONTRACTOR shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the CONTRACTOR shall consult

3.2 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the CONTRACTOR shall remove the abandoned pipe for a distance of 5-feet from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-inches diameter or greater shall be completely sand-filled prior to closure of the piping ends.

3.3 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by WORK necessary to complete modifications under this Contract. The CONTRACTOR shall be responsible to rehabilitate those areas affected by its construction activities.

B. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-inches. The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

C. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately 1/2-inch and the recessed area filled with cement mortar grout.

D. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

3.4 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities that shall not be closed or obstructed without permission from the OWNER. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.5 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The CONTRACTOR shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.6 CLEANING

A. During and upon completion of WORK, the CONTRACTOR shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by WORK in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as requested by the ENGINEER or directed by governing authorities, and adjacent areas shall be returned to condition existing prior to start of WORK.

END OF SECTION

SECTION 03 01 30 - CONCRETE REPAIR AND REHABILITATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Remove, repair, or rehabilitate new and existing concrete members and surfaces as indicated.

B. Provide all materials and equipment necessary to accomplish the WORK.

C. Repair damage to concrete and concrete surfaces which results from the removal of embedded items, from construction activities, or which existed previously in structures indicated to be repaired.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ACI 201.1R-08	Guide for Conduction a Visual Inspection of Concrete in Service
ACI 546R-14	Guide to Concrete Repair

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit Shop Drawings for strengthening required around new openings.

2. Submit detailed drawings showing proposed methods for supporting existing structures, equipment, and piping during demolition and repair activities.

C. Concrete Repair Products and Procedures

1. Submit a comprehensive plan for each repair method indicated within this Section, the plan shall include the following:

a. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each product.

b. Curing products and procedures for each repair method for which curing is recommended by the manufacturer.

1.4 QUALIFICATIONS OF CONCRETE RESTORATION FIRMS

A. The concrete restoration WORK shall be performed by an experienced firm customarily engaged in performing similar repair work on cast-in-place concrete structures.

B. The restoration firm shall have completed at least 5 similar projects in the last 5 years.

C. The restoration firm shall be certified by the manufacturer of the repair materials.

1.5 QUALITY ASSURANCE

A. General

1. Any material, already placed, which fails to meet the indicated performance requirements is subject to removal and replacement as part of the WORK.

2. The CONTRACTOR shall supply all necessary materials for fabricating the test specimens.

B. Repair Mortar

1. The CONTRACTOR's approved agency per 2015 IBC Section 1704 shall take compression test specimens during construction from the first placement of each type of repair mortar.

2. The cost of laboratory tests on repair mortar shall be paid by the CONTRACTOR, and the CONTRACTOR shall be responsible for the cost of any additional tests and investigation on the WORK that does not meet the indicated requirements.

3. The compression tests and fabrication of specimens for repair mortar shall be performed as specified in ASTM C 109.

a. A set of 3 specimens shall be made for testing at 7 days and 28 days, and an additional 2 specimens shall be made and held in reserve.

C. Non-Shrink Grout: Non-shrink grout shall be tested as required in Section 03 60 00 – Grouting.

D. Repair Concrete: Repair concrete shall be tested as required in Section 03 31 00 – Cast-in-Place Concrete.

E. Epoxy Grout: Epoxy grout shall be tested as required in Section 03 60 00 – Grouting.

F. Construction Tolerances: Construction tolerances shall comply with the requirements of Section 03 31 00 – Cast-in-Place Concrete, except as otherwise indicated.

PART 2 -- PRODUCTS

2.1 REPAIR MORTAR

A. Provide repair mortar as a pre-packaged, 2-component, polymer-modified, cementious, non-sag mortar, specifically formulated for the repair of surface defects.

B. Provide the mortar with a penetrating corrosion inhibitor.

C. Repair mortar shall have the following properties:

Physical Property	Value	ASTM Standard
Compressive Strength (min.)		C-109
at 7 days	6000 psi	
at 28 days	7000 psi	
Bond Strength (min.) at 28 days	2200 psi	C-882 (modified)
Freeze/Thaw resistance (min.) 300 cycles	98 percent	C-666

D. Provide a minimum repair thickness of 1/4 inch, unless otherwise indicated.

E. Repair Mortar shall be **SikaTop 123 Plus**, by **Sika Corporation**, or equal.

2.2 NON-SHRINK GROUT

A. Provide non-shrink grout conforming to the requirements of Section 03 60 00 – Grouting.

2.3 CONCRETE MATERIALS

A. Cement

1. Use Type II Portland cement unless otherwise indicated.

2. Where repairs are to be made on wall surfaces open to view and above normal water surface elevations, blend white Portland cement with the Type II cement as needed in order to match the color of the adjacent existing concrete surface.

B. Structural Repair Grout

1. Where required, provide structural repair grout meeting the requirements of Section 03 60 00 – Grouting.

2. Provide a minimum repair thickness of 3 inches.

C. Cement Grout

1. Provide cement grout that meets the requirements of Section 03 60 00 – Grouting.

2. Provide a minimum repair thickness of one inch.

D. Miscellaneous Materials**:** For concrete construction materials not covered specifically in this Section, conform to the requirements of Section 03 31 00 – Cast-in-Place Concrete.

2.4 AGGREGATE

A. Obtain the written permission of the manufacturer and ENGINEER before using aggregate to extend repair mortar and grout products.

B. If allowed and unless otherwise indicated, provide aggregate consisting of 3/8-inch clean, washed gravel or crushed stone as required in Section 03 31 00 – Cast-in-Place Concrete.

2.5 BONDING AGENT AND ANTI-CORROSION COATING

A. Provide a bonding agent that is a solvent-free, moisture-tolerant, epoxy-modified, cementitious product, specifically formulated as a bonding agent and anti-corrosion coating.

B. Bonding Agent shall be **Armatec 110 EpoCem**, by **Sika Corporation**, or equal.

2.6 EPOXY GROUT

A. Provide an epoxy grout conforming to the requirements of Section 03 60 00 – Grouting.

2.7 EPOXY RESIN

A. Use epoxy resin for structural crack repair.

B. For crack injection, provide a 2-component, moisture-tolerant, low-viscosity, high-strength epoxy resin adhesive that is specially formulated for that usage.

C. Provide a minimum bond strength of 2900 psi when tested per ASTM C 882 at 14 days, moist cured.

D. Epoxy Resin shall be **Sikadur 35, Hi-Mod LV**, by **Sika Corporation**, **KEMKO 068 LoVis IR**, by **ChemCo Systems, Inc.**, or equal.

2.8 FORMWORK

A. Where needed, provide formwork that meets the requirements of Section 03 11 00 – Concrete Formwork.

2.9 REINFORCEMENT STEEL

A. Where required, provide reinforcing steel that meets the requirements of Section 03 21 00 – Reinforcement Steel.

2.10 POLYURETHANE SEALANT

A. Provide a 2-part polyurethane, gun-grade sealant.

B. Polyurethane Sealant shall be **Sikaflex – 2C**, by **Sika Corporation**, or equal.

2.11 POLYURETHANE CHEMICAL GROUT

A. Use polyurethane chemical grout for non-structural crack repair.

B. Polyurethane Chemical Grout shall be **SikaFix HH**, by **Sika Corporation**, **Flex LV PURe**, by WR **Grace/De Neef**, **Flex SLV PURe**, by **WR Grace/De Neef**, or equal.

2.12 EXPANSION JOINTS

A. Provide an expansion joint system for repair of the existing expansion joints, consisting of a Hypalon sealing strip and an epoxy adhesive in order to provide a watertight seal.

B. Expansion Joint System shall be **Sikadur Combiflex**, by **Sika Corporation**, or equal.

2.13 HYDROPHILIC WATERSTOP

A. Provide hydrophilic waterstop of the type which expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

B. Provide hydrophilic waterstop that is bentonite-free and manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties.

C. Hydrophilic Waterstop shall be **Hydrotite RSS-040 P**, by **Greenstreak Group, Inc.**, KM **4mm String**, by **Adeka Ultra Seal**, or equal.

2.14 HIGH STRENGTH EPOXY GEL

A. High-Strength Epoxy Gel for crack surface sealing shall be **Denepox Rapidgel**, by **WR Grace/De Neef**, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Repairs

1. Repair techniques will be reviewed during the pre-construction meeting between the CONTRACTOR and ENGINEER.

2. The CONTRACTOR shall be familiar with the cause of deteriorated concrete and shall choose the right equipment, repair materials and techniques to be used for each particular repair.

3. Choose repair materials to match the adjacent concrete surface in color and texture.

4. Apply repair materials in strict accordance with the manufacturer's printed instructions, including temperature and moisture requirements throughout application and curing.

5. Protect adjacent portions of the structure, including all valves, pipes, mechanical equipment, and filter media from debris generated by repair activities.

6. For portions of the structure that are not identified to be repaired, maintain in their original condition.

B. Structural Stability

1. Use caution not to weaken the structural capacity of a beam, column, wall, slab, walkway, or other concrete member during concrete removal.

2. For severely deteriorated concrete members, consult with the ENGINEER before removing a major portion of any structural member.

3. Shoring may be required in order to support the structure and to protect workers.

C. Provide off-site disposal of debris generated as a result of repair procedures.

D. Provide concrete construction procedures not specifically addressed in this Section in accordance with the requirements of Section 03 31 00 – Cast-in-Place Concrete.

3.2 REPAIR SEQUENCING

A. Unless otherwise indicated, perform concrete repairs in the following sequence, with no activity in an area being started until previous activities in that area have been completed, including curing, cleanup, and the like:

1. removal of equipment, miscellaneous metals, and other surface features that would interfere with the repair;

2. removal of concrete sections which require complete replacement;

3. surface preparation hydroblasting over the entire area to be repaired;

4. embedded metal repair;

5. crack repair;

6. filter trough to wall connection repair;

7. spalled and delaminated concrete repair;

8. scaled concrete;

9. pop-out repair, and repair of other surface damage, deterioration, or defects;

10. patching of holes in concrete;

11. replacement of concrete sections which require complete replacement;

12. new construction;

13. application of protective coatings;

14. expansion joint repair; and,

15. installation of traffic topping.

B. For areas which require combinations of spalled and delaminated concrete repair, scaled concrete, and pop-out repair, perform these repairs at the same time.

C. Limit the size of the repair area in order to permit the repairs to be performed together, without sacrificing the quality of the individual repairs.

3.3 EMBEDDED METAL REPAIR

A. Unless otherwise indicated, repair anchor bolts and other embedded metal, except rebar, that are exposed at the concrete surface and are showing signs of corrosion, as follows:

1. Cut off or otherwise remove corroded metal fastened at the surface;

2. Burn back embedded metals to a depth of at least 1.5 inches beyond the surface of sound concrete;

3. Chip away unsound concrete around the embedded metal.

4. Apply epoxy grout to the repair area until level with the surface of the surrounding sound concrete.

B. Unless otherwise indicated, repair embedded rebar that is exposed at the concrete surface following the procedures outlined in the appropriate concrete repair subsection, below.

3.4 CRACK REPAIR

A. Structural Cracks - Structural Cracks are defined as follows:

1. All cracks where reinforcing steel is passing across the crack, including erratic cracks, and cracks at construction joints.

2. Repair structural cracks with epoxy resin.

B. Non Structural Cracks - Non Structural Cracks are defined as follows:

1. Cracks occurring at flexible joints, contraction joints or expansion joints.

2. Repair non-structural cracks with polyurethane chemical grout.

C. Efflorescence

1. Prior to the crack repair, clean efflorescence from the cracks and the surrounding area.

2. Clean the efflorescence by light hydro-blasting or scrubbing.

D. Pressure Injection: Pressure Injection to be performed prior to leak testing and roof membrane installation.

1. General

a. The indicated repair materials have been selected to minimize the loss of material during the injection process. The areas selected for crack repair are to be identified by the CONTRACTOR or ENGINEER and be determined prior to leak tests and roof membrane installation. The injection of cracks may also be required as a result of the leak test.

b. In order to avoid excessive loss of injected material at the lower exposed portions of the cracks, space the injection ports a distance no greater than the thickness of the wall being repaired.

2. Open through thickness structural cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. All 3 foot long minimum or greater through thickness cracks greater than a minimum 15 mil thickness in the walls are to be injected unless they do not accept grout. All 2 foot long minimum through thickness cracks greater than 10 mil thickness in the foundation, water conduits, floor slabs and roof are to be injected unless they do not accept grout. Perform structural crack repairs by pressure injection in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

b. Remove any contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. For potable water applications, any solvents must be fully flushed from the joint unless NSF/ANSI Standard 61 approved.

c. Install the injection ports in accordance with the manufacturer's directions.

d. Sealing

1) Seal the surface in order to keep the pressure injecting materials from leaking out before it has set or gelled.

2) Seal a surface by brushing an epoxy over the surface of the crack and allowing it to harden, or use high injection pressures to cut-out the cracks in a 'V' shape, fill with an epoxy, and strike off flush with the surface.

3) Surface patching or sealant shall be performed where needed to provide for complete penetration of the injected polyurethane grout and to prevent wastage. Seal surface of crack with fast setting hydraulic cement or high strength epoxy gel. The floor surface along the cracks shall be cleaned and all wasted grout and surface seal material shall be completely removed from the concrete surface following completion of the repair work

e. Inject the repair materials, with consideration of the following items:

1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, then cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled.

3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end, using low-viscosity repair material.

f. Cleanup

1) Remove the surface seal by grinding or other appropriate means.

2) Coat fittings and holes at injection ports with an epoxy patching compound.

3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3. Open through thickness non-structural cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. Open through thickness cracks with lengths of at least 3 feet on each side of the wall and roof, at least 2 feet

of length on the foundation or floor slab are to be injected unless they do not accept grout. All 3 foot long minimum or greater through thickness cracks greater than a minimum 15 mil thickness in the walls are to be injected unless they do not accept grout. All 2 foot long through thickness cracks greater than 10 mil thickness in the floors and roof are to be injected unless they do not accept grout. Perform non-structural crack repairs in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

b. Remove contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. Any solvents must be fully flushed from the joint unless NSF/ANSI Standard 61 approved.

c. Install the injection ports in accordance with the manufacturer's directions.

d. Moisture

    1) For non-structural cracks, moisture must be present for the chemical grout to react.

    2) Prior to injecting the repair materials, inject the crack with a small amount of water in order to completely moisten the crack.

e. Inject the repair materials, with consideration of the following items:

    1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

    2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled, and then, starting again at the lowest port, re-inject into all ports in order to ensure that all voids are properly sealed off.

    3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

    4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end.

f. Cleanup

    1) Remove excess surface material by grinding or other appropriate means.

    2) Coat fittings and holes at injection ports with an epoxy patching compound.

    3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3.5 SPALLED AND DELAMINATED CONCRETE REPAIR

A. Repair spalls and delaminated concrete using repair mortar.

B. Surface Preparation

1. Remove all delaminated concrete and all unsound concrete beyond the spalled or delaminated area.

2. Boundaries

   a. Determine the boundaries of the patch by sawcuts to a depth of at least 1/4 inch up to one inch deep.

   b. Refer to the Structural Drawings for sawcut locations.

   c. Where the sawcut locations are not shown on the Drawings, the boundaries shall be layouts designed to reduce boundary edge length.

   d. Avoid excessive or complex edge conditions.

3. Sawcuts

   a. Perform sawcuts perpendicular to the surface or slightly undercut.

   b. Construct sawcuts in maximum 1/4-inch increments.

   c. After each incremental cut, inspect the cut surface in order to ensure that the existing reinforcement has not been cut.

   d. If at any depth the reinforcement becomes exposed, terminate the sawcut and notify the ENGINEER.

4. Chip away concrete within the repair area to a depth sufficient to expose sound concrete over the entire repair area, or to a minimum depth required by repair mortar, whichever is greater.

5. Base the selection of partial depth concrete removal equipment on the size of repair area, depth of concrete to be removed, and the location of the deteriorated concrete such as wall, slab-on-grade, underside or top of elevated slab.

6. Removal

   a. The maximum allowable pneumatic chipping hammer shall be a 30-lb class hammer.

   b. Hydroblast removal shall use a maximum pressure of 40,000 psig.

   c. Sand blasting is not permitted.

   d. Hydroblast concrete removal is recommended for large area of surface defects.

   e. Remove water blasting debris daily in order to prevent it from setting up.

f. If a chipping hammer is used, ensure that the existing reinforcement is not damaged during the concrete removal operations.

g. Remove protrusions, such as mortar spatter or fins, by grinding or by striking with a hammer or other tool.

7. Reinforcement

a. Remove concrete from around reinforcement when the rebar is rusted, more than half the rebar perimeter is already exposed, the concrete bond around the rebar is broken, or if the concrete is unsound or honey-combed.

b. Remove concrete in order to provide a clear space of minimum one inch on all sides of the reinforcement, such that the rebar can be cleaned, and the repair material will completely surround the rebar.

c. Clean exposed reinforcement by water blasting or wire brushing.

d. After fully exposing and cleaning the reinforcement, check for steel deterioration, and if the cross-sectional area of the steel has been reduced by more than 10 percent, whether by deterioration, surface preparation, or a combination of both, provide additional reinforcement.

e. Consult with the ENGINEER before adding or replacing rebar.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning the reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Repair Mortar

a. Apply repair mortar in accordance with the manufacturer's recommendations.

b. The thickness of each lift of repair mortar shall be in accordance with the manufacturer's recommendations, with the minimum thickness being not less than 1/4 inch.

7. Fully consolidate the repair mortar, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

10. Float-finish the repaired surface using wood or sponge floats.

11. For repaired surfaces to receive a protective coating, brush-finish the surface in order to produce a roughened substrate for the coating.

12. Minimum and maximum ambient and surface temperatures shall be as recommended by repair material manufacturer.

D. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

c. Ensure that edges are continuously held in place; and,

d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.6 SCALED CONCRETE REPAIR

A. Repair scaling and pop-outs using repair mortar.

B. Surface Preparation

1. Prior to repair, prepare the surface in accordance with the repair mortar manufacturer's recommendations with the following minimum requirement.

2. Remove unsound concrete from surfaces by high-pressure water blasting, using a minimum pressure of 10,000 psigg and maximum pressure of 40,000 psigg.

3. Clean exposed reinforcement by water blasting or wire brushing.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Apply repair mortar in accordance with the manufacturer's recommendations, using a minimum repair material thickness of 1/4 inch.

7. Fully consolidate the repair material, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

10. Float-finish the repaired surface using wood or sponge floats.

D. Provide strip joint in newly placed mortar at the location of repaired cracks.

E. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

   a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

   b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

   c. Ensure that edges are continuously held in place; and,

   d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 degrees F for at least 3 days after placement.

3.7 POP-OUT REPAIR, AND REPAIR OF OTHER SURFACE DAMAGE, DETERIORATION, OR DEFECTS

A. Repair pop-outs and other surface damage, deterioration, and defects which are 1/4 inch deep or shallower, using the procedures described under "SCALED CONCRETE REPAIR," above.

B. Repair other pop-outs and surface damage, deterioration, and defects using the procedures described under "SPALLED AND DELAMINATED CONCRETE REPAIR," above.

3.8 REPLACEMENT OF CONCRETE SECTIONS WHICH REQUIRE COMPLETE REPLACEMENT

A. Refer to the Structural Drawings for locations where the level of concrete deterioration is such that complete removal and replacement of the deteriorated section is required.

B. At these locations, remove the deteriorated concrete in accordance with the details on the Structural Drawings and the requirements of this Section.

C. Limits

1. The limits of concrete removal shall be as indicated on the Structural Drawings.

2. If no limits of removal are indicated, determine the limits in accordance with the procedures described under “Boundaries – Spalled and Delaminated Concrete Repair.”

D. Provide sawcuts in accordance with the procedures described under “Sawcuts – Spalled and Deliminated Concrete Repair.”

E. After removal of the concrete, prepare the area and provide repair concrete in accordance with the details on the Structural Drawings and the requirements of this Section.

F. Unless otherwise indicated, match the finished cross-section of the repaired concrete to the cross-section of the adjacent undamaged concrete.

3.9 PATCHING OF HOLES IN CONCRETE

A. General

1. For the purposes of this Section, holes are defined as penetrations completely through the concrete member and with interior surfaces approximately perpendicular to the surface of the existing member.

2. Interior surface areas which are inclined and do not meet these criteria shall be chipped as needed to meet this requirement.

3. The perimeter of holes at the surface shall form a regular shape composed of curved or straight line segments.

4. Provide the minimum depth of placement for the material used; score the existing concrete by sawcutting, and chip as needed to meet this requirement.

5. Roughen the interior surface of holes less than 12 inches in diameter to a minimum of 0.125-inch amplitude and roughen larger holes to a minimum of 0.25-inch amplitude.

6. At holes, coat the existing surface to be repaired with a bonding agent.

B. Patching Small Holes: For holes which are less than 12 inches in their least dimension and extend completely through concrete members, fill with non-shrink grout.

C. Patching Large Holes

1. Fill holes which are larger than 12 inches in their least dimension with structural repair grout.

2. Provide large holes which are normally in contact with water or soil with hydrophilic waterstop placed in a groove.

3. Alternatively, bond the hydrophilic waterstop to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material.

4. Install the waterstop in accordance with the requirements of Section 03 32 00 – Joints in Concrete.

5. Provide reinforcing steel in layers matching existing reinforcement location, size, spacing and cover requirements unless directed otherwise by the ENGINEER.

6. In locations where NSF/ANSI Standard 61 approval is required by the authority having jurisdiction, use one of the following procedures:

a. Provide Product Data showing the proposed structural repair grout is NSF/ANSI Standard 61 approved.

b. Complete the repair with structural repair grout. Coat all surfaces required to have NSF/ANSI Standard 61 approval completely with Sikadur 31, Tyfo S, or equal.

c. Place the structural repair grout to within 1 ½" of the finished surface of the repair. Complete the remainder of the repair with SikaTop123 Plus, or equal.

3.10 PATCHING OF LINED HOLES

A. General

1. This WORK applies to those openings which have embedded material over all or a portion of their inside edge.

2. The requirements for repairing holes in concrete, as indicated above, apply as modified herein.

3. The COT will determine whether the embedded material is allowed to remain.

B. Where embedded material is allowed to remain, trim it back a minimum of 2 inches from the concrete surface.

C. Roughen or abrade the embedded material in order to promote good bonding to the repair material.

D. Remove substances that interfere with good bonding.

E. Completely remove embedded items that are not securely and permanently anchored into the concrete.

F. Completely remove embedded items which are larger than 12 inches in their least dimension, unless they are composed of a metal to which reinforcing steel can be welded; where reinforcement is required, weld it to the embedded metal.

G. The following requirements shall apply to concrete members which are in contact with water or soil:

1. Using epoxy grout, fill lined openings which are less than 4 inches in their least dimension;

2. Using an epoxy bonding agent, coat lined openings which are greater than 4 inches but less than 12 inches in their least dimension, prior to being filled with non-shrink grout.

3. Using an epoxy bonding agent, coat lined openings which are greater than 12 inches in their least dimension and provide a hydrophilic waterstop bonded to the interior of the opening with epoxy adhesive, prior to being filled with approved repair material.

3.11 APPLICATION OF PROTECTIVE COATINGS

A. Waterproofing

1. Apply waterproofing in accordance with the manufacturer's printed instructions.

2. Do not begin waterproofing WORK until repairs and new construction in the affected area have been completed and adequately cured.

3.12 EXPANSION JOINT REPAIR

A. Repair deteriorated expansion joints as follows:

1. Completely remove existing sealant;
2. Remove defective backer materials in the joint;
3. Sand-blast the joint and prepare the surface in accordance with the sealant manufacturer's instructions;
4. Prepare the wall surface on each side of the joint in accordance with the expansion joint manufacturer's instructions;
5. Ensure that the prepared surface is clean, sound, and bare concrete;
6. Place backer material in the joint;
7. Apply a primer recommended by the sealant manufacturer;
8. Fill the joint with polyurethane sealant;
9. Allow a minimum of 3 days curing prior to installing the expansion joint; and,
10. Install the expansion joint in accordance with the manufacturer's instructions.

END OF SECTION 03 31 30

SECTION 03 11 00 - CONCRETE FORMING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Manufacturer's information demonstrating compliance with requirements for the following:

1. Form ties and related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

3. Form release agent, including NSF certification if not using mineral oil.

4. Manufacturer's information on formwork, form materials, and locations for use.

C. Shop Drawings: Detailed plans for the fabrication and erection of falsework to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Include a list of form materials and locations for use.

D. Falsework Calculations and Drawings: All falsework or vertical shoring installations where the height of the falsework or vertical shoring, as measured from the top of the sills to the soffit of the superstructure, exceeds 14-feet, or where individual horizontal span lengths exceed 16-feet, or provision for vehicular or railroad traffic through falsework or vertical shoring is made, shall be approved and signed by a civil engineer, registered in the State of Washington; provided further, that a copy of the falsework plan or shoring layout shall be available on the Site at all times.

1.3 QUALITY ASSURANCE

A. Tolerances: Tolerances shall be in accordance with Section 03 31 00 – Cast-in-Place Concrete. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

PART 2 -- PRODUCTS

2.1 GENERAL

A. Except as otherwise expressly accepted by the ENGINEER, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Walls	Steel, fiberglass, or plywood panel
Columns	Steel, plywood or fiberglass
Roof and floor	Plywood
All other WORK	Steel panels, fiberglass, plywood or tongue and groove lumber

B. Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

C. Water-based form release agent shall be **Clean Strip J1EF** by **Dayton Superior**, or equal.

2.2 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.

4. Steel leave in place forms shall not be used.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf minimum. The minimum design load for combined dead and live loads shall be 100 psf.

2.3 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1-1/2 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be **ST-4 Hex Head Snap Tie** by **MeadowBurke, Snap-Ties** by **Dayton/Richmond,** or equal.

B. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie**.** Use **HD-9 Taper-Tie** by **MeadowBurke, Taper-Tie** by **Dayton/Richmond,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

C. Forms shall be removed unless approved otherwise by the ENGINEER.

3.2 FORM DESIGN

A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects

in the finished concrete. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1-1/2-inch diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 31 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.

3.3 CONSTRUCTION

A. Vertical Surfaces: Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink

or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3.4 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

3.5 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 Day strength in Section 03 31 00. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 Day strength and has been in place for a minimum of 7 Days. The time required to establish said strength shall be as determined by the ENGINEER who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7 Day minimum, then that time shall be used as the minimum length of time. Forms for vertical walls of water holding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for parts of the WORK not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.6 MAINTENANCE OF FORMS

A. Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.7 FALSEWORK

A. The CONTRACTOR shall be responsible for the design, engineering, construction, maintenance, and safety of falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction,. the requirements of the Safety Standards for Construction Work of the Washington Administrative Code, and the requirements herein.

B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to

support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and be protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

SECTION 03 21 00 - REINFORCEMENT STEEL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide reinforcement steel and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Furnish shop bending diagrams, placing lists, and drawings of reinforcement steel prior to fabrication.

2. Diagrams

a. The shop bending diagrams shall show the actual lengths of bars to the nearest inch, measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface.

b. Include bar placement diagrams that clearly indicate the dimensions of each bar splice.

3. Reinforcement

a. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed.

b. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement, and the indicated requirements.

4. Mechanical Couplers

a. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit the following items:

1) Manufacturer's literature containing instructions and recommendations for installation for each type of coupler.

2) Certified test reports that verify the load capacity of each type and size of coupler used.

3) Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

1.3 QUALITY ASSURANCE

A. Materials Testing

1. If requested by the ENGINEER, furnish samples from each heat of reinforcement steel in a quantity adequate for testing.

2. Costs of initial tests will be paid by the OWNER.

3. Costs of additional tests if material fails initial tests shall be the CONTRACTOR's responsibility.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

A. Materials that may remain or leave residues on or within the concrete shall be certified as compliant with NSF Standard 61- Drinking Water System Components.

2.2 REINFORCEMENT STEEL

A. Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar and spiral reinforcement shall conform to ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement, Grade 60 reinforcement, unless otherwise indicated.

B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement.

2. Bar Supports

a. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars.

b. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 1/2 inch from the concrete surface.

c. Plastic shall be gray in color.

3. Concrete Blocks

a. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located.

b. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A 775 - Epoxy - Coated Reinforcing Steel Bars.

2.3 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the ENGINEER.

B. The couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.

C. Multi-Component Couplers

1. Where the type of coupler used is composed of more than one component, components required for a complete splice shall be provided.

2. This shall apply to mechanical splices, including those splices intended for future connections.

D. Connection

1. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection.

2. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

E. Couplers shall be **Lenton Form Saver** by **Erico Products, Dowel Bar Splicer System** by **Dayton/Richmond**, or equal.

2.4 EPOXY ADHESIVE

A. Epoxy adhesive for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled.

B. Epoxy adhesive shall be in conformance with the requirements of Section 03 60 00 – Grouting.

PART 3 -- EXECUTION

3.1 GENERAL

A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the indicated supplementary requirements.

3.2 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Reinforced Concrete, except as modified by the Drawings.

2. Bars shall be bent cold.

3. Bars shall be bent in accordance with the requirements of ACI 318.

4. Fabricate reinforcement bars for structures in accordance with accepted bending diagrams, placing lists, and placing drawings.

B. Fabricating Tolerances

1. Bars used for concrete reinforcement shall conform to the following fabricating tolerances:

a. Sheared Length: plus and minus one inch

b. Depth of Truss Bars: plus zero, minus 1/2 inch

c. Stirrups, Ties and Spirals: plus and minus 1/2 inch

d. Other Bends: plus and minus one inch

3.3 PLACEMENT

A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement using annealed iron wire ties or suitable clips at intersections.

B. Reinforcement steel shall be supported by concrete, plastic or metal support spacers, or metal hangers that are sufficiently strong and rigid to prevent any displacement of the reinforcement steel.

C. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous.

D. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks.

E. For concrete over formwork, provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

F. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies

a. permitted at any location except where architectural finish is required

b. required for slabs on grade and surfaces in contact with or above ozonated process water

2. Wire bar supports will be permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic bar supports will be permitted at every location except on-grade.

G. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

H. Bars additional to those indicated that may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at no additional expense to the OWNER.

I. Except where in conflict with the Building Code, unless otherwise indicated reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318.

J. Moving Bars

1. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items.

2. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the ENGINEER.

K. Welded Wire Reinforcement

1. Welded wire reinforcement placed over horizontal forms shall be supported on slab bolsters.

2. Slab bolsters shall be spaced not more than 30-inch on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

3. Welded wire reinforcement placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction.

4. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

L. Storage and Handling

1. Epoxy-coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating.

2. Non-abrasive slings made of nylon and similar materials shall be used.

3. Specially coated bar supports shall be used.

4. Chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

M. Accessory Spacing

1. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars.

2. When used to space the reinforcing bars from wall forms, the forms and bars shall be located such that there is no deflection of the accessory when the forms are tightened into position.

3.4 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/2 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.5 SPLICING

A. General

1. Reinforcement bar splices shall only be used at indicated locations.

2. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the ENGINEER.

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 25.5.2.1 for a Class B splice.

2. Welded Wire Reinforcement

a. Laps of welded wire reinforcement shall be in accordance with ACI 318.

b. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet.

c. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. Bending or Straightening

1. Reinforcement shall not be straightened or re-bent in a manner which will injure the material.

2. Bars shall be bent or straight as indicated.

3. Do not use bends different from the bends indicated.

4. Bars shall be bent cold, unless otherwise permitted by the ENGINEER.

5. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

D. Couplers

1. Couplers that are located at a joint face shall be of a type that can be set either flush or recessed from the face as indicated.

2. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering.

E. Unless indicated otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.

3.6 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete has been placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

C. Where there is delay in depositing concrete, the reinforcement shall be re-inspected and, if necessary, re-cleaned.

3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.

3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling, and the location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.

5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

B. Embedment

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole.

2. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets.

3. The hole shall be filled to a depth that ensures excess material will be expelled from the hole during dowel placement.

4. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy.

5. The bar shall be inserted slowly enough to avoid developing air pockets.

END OF SECTION

SECTION 03 31 00 - CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide cast-in-place concrete, as indicated in accordance with the Contract Documents.

B. The following types of concrete are covered in this Section:

1. Structural Concrete: Concrete to be used in all cases except where noted otherwise in the Contract Documents.

2. Sitework Concrete: Concrete to be used for curbs, gutters, catch basins, sidewalks, fence and guard post embedment, underground duct bank encasement, and other concrete appurtenant to electrical facilities, unless otherwise indicated.

C. The term "hydraulic structure" shall mean concrete structures for the containmenttreatment, or transmission of water, wastewater, other fluids, or gases.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Mix Designs

1. Prior to beginning the WORK and within 14 Days of the Notice to Proceed, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete.

2. Mix designs shall be checked through trial batch and laboratory testing by an independent testing laboratory acceptable to the ENGINEER.

3. Costs related to trial batch and related laboratory testing shall be CONTRACTOR’s responsibility as part of the WORK.

4. Since laboratory trial batches require 35 calendar days to complete, the CONTRACTOR shall test a minimum of 2 mix designs for each class of concrete.

C. Delivery Tickets

1. Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete.

2. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix.

3. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was

dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

D. Test Data: Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old.

E. Furnish the following submittals in accordance with ACI 301 – Structural Concrete:

1. mill tests for cement

2. admixture certification, including chloride ion content

3. aggregate gradation test results and certification

4. materials and methods for curing

1.3 CONCRETE CONFERENCE

A. The ENGINEER or OWNER will chair a meeting to review the detailed requirements of the CONTRACTOR's proposed concrete design mixes and to determine the procedures for producing proper concrete construction no later than 14 Days after the Notice to Proceed.

B. Parties involved in the concrete WORK shall attend the conference, including the following at a minimum:

1. CONTRACTOR's representative

2. testing laboratory representative

3. concrete subcontractor

4. reinforcing steel subcontractor and detailer

5. concrete supplier

6. admixture manufacturer's representative

C. The conference shall be held at a time and place proposed by the CONTRACTOR and accepted by the ENGINEER.

1.4 QUALITY ASSURANCE

A. Engage a qualified independent testing agency to perform tests, inspections and to submit test reports to the OWNER

B. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated.

2. Tests for determining slump shall be in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

3. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.

4. The cost of trial batch laboratory tests on cement, aggregates, and concrete shall be the CONTRACTOR's responsibility.

5. The cost of laboratory tests on field-placed cement, aggregates, and concrete and the cost of Special Inspections required by Code will be the OWNER'S responsibility.

6. The CONTRACTOR shall be responsible for the cost of any tests and investigations of WORK that is determined to be Defective WORK.

7. The testing laboratory shall meet or exceed ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.

8. Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

C. Inspections

1. Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the ENGINEER will be required where necessary to conform with Code requirements.

2. Costs of the special inspector shall be paid by the OWNER.

3. Inspection reports shall be submitted to the ENGINEER.

4. The special inspector shall observe the following for conformance to the Contract Documents:

   a. the preparation and taking of required test specimens; and,

   b. placement of concrete, except sitework concrete fully supported on earth.

D. Field Compression Tests

1. Compression test specimens shall be taken during construction from the first placement of each type of concrete and at intervals thereafter as selected by the ENGINEER to insure continued compliance with the Specifications.

2. Each set of specimens shall be a minimum of 5 cylinders.

3. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field.

4. Specimens shall be 6-inches diameter by 12-inches tall cylinders.

5. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens.

6. One test cylinder shall be tested at 7 Days, and 2 test cylinders tested at 28 Days.

7. The remaining cylinders shall be held to verify test results, if needed.

E. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete shall be in accordance with ACI 318 – Building Code Requirements for Reinforced Concrete, Chapter 5 "Concrete Quality," and as indicated.

2. A statistical analysis of compression test results shall be performed according to ACI 214 – Recommended Practice for Evaluation of Strength Test Methods.

3. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.

4. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.

5. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100.

6. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.

7. Concrete that fails to meet the ACI requirements and the indicated requirements is subject to removal and replacement.

F. Shrinkage Tests

1. Drying shrinkage tests shall be performed for the trial batches indicated in the Article below entitled "Trial Batch and Laboratory Tests," for the first placement of each class of structural concrete except pea gravel mix, and during placement to determine continued compliance.

2. Structural pea gravel mix does not need to be tested for shrinkage.

3. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gauge length of 10-inches, and fabricated, cured, dried, and measured in accordance with ASTM C 157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete, modified as follows:

a. Specimens shall be removed from molds at an age of 23 hours, plus or minus one hour, after trial batching, and shall be placed immediately in water at 70 degrees F, plus or minus 3 degrees F, for at least 30 minutes.

b. Specimens shall be measured within 30 minutes thereafter to determine original length and then shall be submerged in saturated lime water at 73 degrees F, plus or minus 3 degrees F.

c. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 Days.

d. This length at age 7 Days shall be the base length for drying shrinkage calculations ("0" days drying age).

e. Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F, plus or minus 3 degrees F, and 50 percent relative humidity, plus or minus 4 percent, for the remainder of the test.

f. Measurements to determine shrinkage, expressed as percentage of base length, shall be performed and reported separately for 7, 14, 21, and 28 Days of drying after 7 Days of moist curing.

4. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age.

5. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age.

6. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004 inch, the results obtained from that specimen shall be disregarded.

7. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage.

8. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens.

9. These tests shall be considered a part of the normal compression tests for the project.

10. Allowable shrinkage limitations are indicated in PART 2 - PRODUCTS, below.

G. Aggregate Testing: Aggregate testing shall be performed for the trial batch in the Article below entitled “Trial Batch and Laboratory Tests” prior to construction and every 12 months during construction to determine continued compliance.

H. Construction Tolerances

1. The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances.

2. Surface defects and irregularities are defined as finishes and are different from tolerances.

3. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings.

4. Where tolerances are not indicated, permissible deviations shall be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.

5. The following non-cumulative construction tolerances apply to finished walls, columns and slabs unless otherwise indicated:

ITEM	TOLERANCE
Variation of the constructed linear outline from the established position in plan.	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation from the level or from the grades indicated.	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation from plumb	in 10 feet: 1/4 inch in 20 feet or more: 1/2 inch
Variation in the thickness of slabs and walls.	minus 1/4 inch plus 1/2 inch
Variation in the locations and sizes of slabs and wall openings	plus or minus 1/4 inch

PART 2 -- PRODUCTS

2.1 CONCRETE MATERIALS

A. General

1. Concrete materials in contact with potable water shall be classified as acceptable for potable water use in accordance with NSF/ANSI Standard 61 as required by the authority having jurisdiction. Not all products listed herein are for use in contact with potable water.

2. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.

3. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage.

4. Cement reclaimed from cleaning bags or leaking containers shall not be used.

5. Cement shall be used in the sequence of receipt of shipments.

B. Materials and storage of materials shall comply with ACI 301, as applicable.

C. Materials for concrete shall conform to the following requirements:

1. Cement

a. Cement shall be standard brand Portland cement conforming to ASTM C 150 – Portland Cement, for Type II or Type V, including Table 2 optional requirements.

b. A minimum of 85 percent of cement by weight shall pass a 325 screen.

c. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER.

d. The cement shall be suitably protected from exposure to moisture until used.

e. Cement that has become lumpy shall not be used.

f. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling.

g. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with the Specifications.

2. Water

a. Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities.

b. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies.

c. Agricultural water with high total dissolved solids (greater than 1000 mg/L TDS) shall not be used.

3. Aggregates

a. Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33 – Concrete Aggregates.

b. The maximum size of coarse aggregate shall be as indicated, and the substitution of lightweight sand for fine aggregate will not be permitted.

c. Coarse Aggregates

1) Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof.

2) The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates, with a maximum size greater than 3/4 inch.

3) When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined (also refer to the Article below entitled "Trial Batch and Laboratory Tests").

d. Fine Aggregates

1) Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable.

2) When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test.

3) The gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2.

4) The fineness modulus of sand used shall not be greater than 3.1.

5) When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

e. Combined Aggregates

1) Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation characteristics.

2) Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

3) When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

f. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. Ready-mixed concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.

5. Admixtures

a. Admixtures shall be compatible and shall be furnished by a single manufacturer capable of providing qualified field service representation.

b. Admixtures shall be used in accordance with manufacturer's recommendations.

c. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture.

d. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

e. Air Content

1) An air-entraining agent meeting the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used.

2) Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent.

3) The OWNER reserves the right, at any time, to sample and test the air-entraining agent.

4) The air-entraining agent shall be added to the batch in a portion of the mixing water.

5) The solution shall be batched by means of a mechanical batcher capable of accurate measurement.

6) Air content shall be tested at the point of placement.

7) The air entraining agent shall be Micro-Air by Master Builders; Daravair by W.R. Grace; Sika AEA-15 by Sika Corporation; or equal

f. Set-Controlling and Water-Reducing Admixtures

1) Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER's approval, to control the set, effect water reduction, and increase workability.

2) The cost of adding an admixture shall be the CONTRACTOR's responsibility.

3) Concrete containing an admixture shall be first placed at a location determined by the ENGINEER.

4) Admixtures shall conform to ASTM C 494 – Chemical Admixtures for Concrete.

5) The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

6) Concrete shall not contain more than one water-reducing admixture, unless it can be demonstrated that the proposed mix will meet the indicated drying shrinkage requirements.

7) The set-controlling admixture may be either with or without water-reducing properties.

8) Where the air temperature at the time of placement is expected to be consistently greater than 80 degrees F, a set-retarding admixture such as **Plastocrete 161MR by Sika Corporation**, **Pozzolith or Delvo** by **BASF**, **Daratard** by **W.R. Grace**, or equal shall be used.

9) Where the air temperature at the time of placement is expected to be consistently less than 40 degrees F, a non-corrosive set accelerating admixture such as **Plastocrete 161FL** by **Sika Corporation**, **MasterSet FP 20** by **BASF**, **Daraset** by **W.R. Grace**, or equal shall be used.

10) Mid-Range Water Reducers

a) General use water-reducing admixtures shall be mid-range and shall conform to ASTM C 494, Type A and F.

b) Use Daracem by **W.R. Grace, Polyheed** by **BASF**, **Sikament** by **Sika Corporation**, or equal.

c) The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

11) High-Range Water Reducers

a) High-range water reducers shall conform to ASTM C 494, Type F or G.

b) Use **ADVA** by **W.R. Grace**, **ViscoCrete** by **Sika Corporation**, **Glenium** by **BASF**, or equal.

c) The high-range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified.

d) No more than 14 ounces of water reducer per sack of cement shall be used.

e) The water reducer shall be considered as part of the mixing water when calculating the water/cement ratio.

f) If the high-range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant.

g) Concrete shall have a slump of 3 inches, plus or minus 1/2 inch, prior to adding the high-range water reducing admixture at the Site.

h) The high-range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician.

i) A standby system shall be provided and tested prior to each day's operation of the primary system.

j) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high-range water reducer, unless recommended otherwise by the manufacturer.

g. Other Admixtures

1) Flyash

a) Fly ash may be substituted for not more than 15 percent, by weight, of cement in structural concrete and not more than 30 percent, by weight, for sitework concrete, and not more than 50 percent, by weight, of cement in other concrete.

b) Fly ash shall conform to ASTM C618 and shall not have loss-on-ignition greater than 3 percent.

c) The water/cement ratio shall be calculated based on cement plus fly ash.

2) Ground Blast Furnace Slag Cement

a) Slag cement shall not be used for concrete sections in hydraulic structures.

b) Slag cement shall conform to ASTM C989 – Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars, Grade 100 or 120.

c) Blended cements shall conform to ASTM C595 – Blended Hydraulic Cements, Type 1S, or ASTM C1157 – Performance Specification for Hydraulic Cement.

d) Slag cement substitution, if used, shall be not less than 25, nor more than 50 percent by weight of cement.

e) Slag cement substitution shall not be used with fly ash substitution.

f) The water/cement ratio shall be calculated based on cement plus slag cement.

2.2 CURING MATERIALS

A. General: Curing compounds shall be resin-based and shall be compliant with local VOC requirements, unless otherwise indicated herein.

B. Regular Curing Compound

1. Regular curing compound shall be white-pigmented and shall conform to ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, Class B.

2. Sodium silicate compounds will not be accepted.

3. The concrete curing compound shall be:

a. Kurez VOX White Pigmented by Euclid Chemicals Company;

b. L&M Cure R-2 by L&M Construction Chemicals;

c. 1200-White by W.R. Meadows;

d. Kure-N-Seal WB White Pigmented by Sonneborn/Degussa Building Systems;

e. or equal.

C. Dissipating Curing Compound

1. When the curing compound must be removed for finishes or grouting, compounds shall be of a dissipating type, conforming to ASTM C 309, Type 1 or 2, Class B.

2. The dissipating curing compound shall be:

a. Korez DR VOX by Euclid Chemical Company;

b. L&M Cure R-2 by L & M Construction Chemicals;

c. 1100-Clear by W.R. Meadows;

d. or equal.

D. Curing Compound for Applications Requiring NSF/ANSI Standard 61 Compliance

1. When the curing compound is required to conform to NSF/ANSI Standard 61, the curing compound shall be water-based and shall be compliant with all local VOC requirements; shall conform to ASTM C 309; and shall be certified to conform to the requirements of NSF/ANSI Standard 61.

2. The NSF/ANSI Standard 61 Certified curing compound shall be:

    a. E-Cure by SpecChem, LLC;

    b. Atlas Quantum-Cure NSF by Atlas Tech Products;

    c. or equal.

E. Concrete Curing Blanket

1. Polyethylene Sheets

    a. Polyethylene sheets for use as concrete curing blanket shall be white and shall have a nominal thickness of 6 mils.

    b. The loss of moisture when determined in accordance with ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.

2. Polyethylene-Coated Waterproof Paper

    a. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, shall have a nominal thickness of 2-mils, and shall be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant).

    b. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.

3. Polyethylene-Coated Burlap

    a. Polyethylene-coated burlap for use as concrete curing blanket shall be 4 mils thick, with white opaque polyethylene film impregnated or extruded into one side of the burlap.

    b. The burlap shall weigh not less than 9 ounces per square yard.

    c. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.

F. Curing Mats

1. Curing mats for use in Curing Method 6, below, shall be heavy shag rugs or carpets or cotton mats quilted at 4 inches on center.

2. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

G. Evaporation Retardant

1. An evaporation retardant shall be used.

2. The evaporation retardant shall be:

   a. MasterKure ER 50 by BASF/Master Builders;

   b. Eucobar by Euclid Chemical Company;

   c. E-CON by L & M Construction Chemicals, Inc.;

   d. or equal.

2.3 NON-WATERSTOP JOINT MATERIALS

A. Materials for non-waterstop joints in concrete shall conform to the following requirements:

1. The preformed joint filler shall be a non-extruding neoprene sponge or polyurethane type conforming to Section 03 32 00 – Joints in Concrete.

2. The elastomeric joint sealer shall conform to Section 07 92 13 – Sealants and Caulking.

3. Mastic Joint Sealer

   a. The mastic joint sealer shall be a material:

      1) that does not contain evaporating solvents;

      2) that will tenaciously adhere to concrete surfaces;

      3) that will remain permanently resilient and pliable;

      4) that will not be affected by the continuous presence of water;

      5) that will not in any way contaminate potable water;

      6) and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement from expansion and contraction.

   b. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants.

   c. The sealer shall be capable of meeting the indicated test requirements, if testing is required by the ENGINEER.

2.4 MISCELLANEOUS MATERIALS

A. Bonding Agents

1. Bonding agents shall be epoxy adhesives.

2. Bonding agents for bonding freshly-mixed, plastic concrete to hardened concrete shall be:

a. Sikadur 32 Hi-Mod Epoxy Adhesive by Sika Corporation;

b. MasterEmaco ADH 326 by BASF/Master Builders;

c. BurkEpoxy MV by Edoco;

d. or equal.

3. Bonding agents for bonding hardened concrete or masonry to steel shall be:

a. Sikadur 31 Hi-Mod Gel by Sika Corporation;

b. BurkEpoxy NS by Edoco;

c. Concresive Paste (LPL) by MBT/Degussa Building Systems;

d. or equal.

B. Vapor Retarder

1. The vapor retarder shall be a plastic sheet meeting the Class A permeance and strength requirementsof ASTM E 1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs. The minimum thickness shall be 10 mils.

2. The vapor retarder shall be **Griffolyn Type-65 G** by **Reef Industries, Inc.**, or equal.

2.5 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated.

2. The exact proportions in which these materials are to be used for different parts of the WORK shall be determined during the trial batches.

3. In general, the mix shall be designed to produce a concrete capable of being deposited to obtain maximum density and minimum shrinkage, and, where deposited in forms, to have good consolidation properties and maximum smoothness of surface.

4. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items.

5. The proportions shall be changed whenever necessary or desirable to meet the required results, and such changes shall be subject to review by the ENGINEER.

B. Fine Aggregate Composition

1. In mix designs for structural concrete, except for 1/2-inch and 3/8-inch maximum size aggregate, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table:

FINE AGGREGATE	
Fineness Modulus	Percent (maximum)
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

2. For other concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50 percent.

C. Water/Cement Ratio

1. The indicated water/cement ratio is for a saturated-surface dry condition of aggregate.

2. Throughout every Day, the added batch water shall be adjusted for the total free water in the aggregates, which shall be determined as follows:

   a. The total moisture content of all aggregate shall be calculated by ASTM C 566 – Test Method for Total Moisture Content of Aggregate by Drying.

   b. Subtract the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.

   c. Subtract the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

D. Concrete Property Tables

1. The maximum cement contents (determined from the maximum W/C Ratios and maximum Water Contents given in the Concrete Property Tables below) are intended to minimize drying shrinkage and heat of hydration of the concrete.

2. It is understood that the indicated maximum cement contents may require additional water reducing agent for the workability required by the CONTRACTOR'S methods, and may not result in the least costly concrete mix for the required concrete strength.

3. If the CONTRACTOR wishes to increase the maximum cement content for any mix, the CONTRACTOR must notify the ENGINEER in writing and submit the request within 30 days of the Notice to Proceed.

4. Increases in cement content shall be at the CONTRACTOR'S expense.

STRUCTURAL CONCRETE

Type of WORK	Regular Mix (roof, floor slabs, walls, pavements, and other concrete items not categorized elsewhere)	Sitework Concrete (curbs, gutters, sidewalks, catch basins, fence embedments, encasements, and ductbanks)	Lean Concrete (thrust blocks, pipe trench cut-off blocks, and cradles)
Min 28 Day Compressive Strength, psi	4500	3000	2000
Max Aggregate Size, in	1	1	1
Cement Content per cubic yard, lb, minimum	564	470	376
Water content per cubic yard, lb, maximum	254	254	270
Max W/C Ratio by weight	0.42	0.45	0.60
Total Air Content, percent	3 to 6	3 to 6	3 to 6
Slump	4 inches +/- 1 in with high-range water reducer: 7 inches +/- 2 in	4 inches +/- 1 in Ductbanks and encasements: 5 inches +/- 1 in	4 inches +/- 1 in

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR shall be responsible for providing concrete with the required workability and strength.

E. Adjustments to Mix Design

1. The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability.

2. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional compensation because of such changes.

3. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and shall be tested again in accordance with the indicated requirements.

2.6 CONSISTENCY

A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface.

B. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, in order to maintain uniform production of a desired consistency.

C. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.

D. The slumps shall be as indicated with the concrete properties.

2.7 TRIAL BATCH AND LABORATORY TESTS

A. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch testing requirements.

B. Before placing any concrete, a testing laboratory selected by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR.

C. Aggregate Proportions

1. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties.

2. If one size range produces an acceptable mix, a second size range need not be used.

3. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the CONTRACTOR.

4. Concrete shall conform to the indicated requirements whether the aggregate proportions are from the CONTRACTOR's preliminary mix design or whether the proportions have been adjusted during the trial batch process.

5. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project.

D. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage and 6 compression test specimens from each batch.

E. The determination of compressive strength shall be made by testing 6-inch diameter by 12-inch high cylinders, which have been made, cured, and tested in accordance with ASTM C 192 – Practice for Making and Curing Concrete Test Specimens in the Laboratory, and ASTM C 39.

F. The testing schedule shall be 3 compression test cylinders tested at 7 Days and 3 at 28 Days.

G. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall be not less than 125 percent of the indicated compressive strength.

H. A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates, and values shall be provided for percent passing each sieve.

2.8 SHRINKAGE LIMITATION

A. General

1. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements.

2. Shrinkage limitations shall apply only to structural concrete.

B. Maximum Shrinkage

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-Day drying age or at 28-Day drying age, shall be 0.036 percent or 0.042 percent, respectively.

2. Standard deviation will not be considered.

3. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.

C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions to reestablish compliance:

1. changing the source of aggregates, cement and/or admixtures;

2. reducing water/cement ratio;

3. washing of coarse and/or fine aggregate to reduce fines;

4. increasing the number of construction joints;

5. modifying the curing requirements; or

6. other actions to minimize shrinkage or the effects of shrinkage.

2.9 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the CONTRACTOR and acceptable to the ENGINEER.

B. Weighing Tolerances

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

2.10 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent.

B. The water feed control mechanism shall be capable of being locked in position in order to constantly deliver the required amount of water to each batch of concrete.

C. A positive, quick-acting valve shall be used for a cut-off in the water line to the mixer, and the operating mechanism shall prevent leakage when the valve is closed.

2.11 READY-MIXED CONCRETE

A. General

1. Ready-mixed concrete that meets the indicated requirements as to materials, batching, mixing, transporting and placement shall be used. It shall be in accordance with ASTM C 94 and the following supplementary requirements.

2. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within 90 minutes after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.

3. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted.

4. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted.

5. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

B. Counters

1. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified.

2. The counter shall be of the resettable, recording type and shall be mounted in the driver's cab.

3. The counters shall be actuated at the time of starting the mixers at mixing speeds.

C. Mixing

1. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment.

2. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed.

3. Materials, including the mixing water, shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

D. Uniformity

1. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading.

2. If slump tests taken at approximately the 1/4- and 3/4-point of the load during discharge result in slumps differing by more than one inch when the required slump is 3 inches or less, or if they differ by more than 2 inches when the required slump is more than 3 inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests.

3. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

E. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the ENGINEER in accordance with the Paragraph in Part 1 of this Section entitled "Delivery Tickets."

PART 3 -- EXECUTION

3.1 PROPORTIONING AND MIXING

A. Proportioning of the mix shall conform to ACI 301.

B. Mixing shall conform to ACI 301.

C. Slumps shall be as indicated.

D. Re-tempering of concrete or mortar that has partially hardened will not be permitted.

3.2 PREPARATION OF SURFACES FOR CONCRETING

A. General

1. Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon.

2. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. Joints in Concrete

1. Construction joints are defined as concrete surfaces upon which or against which concrete is to be placed, but placement of concrete has been stopped or interrupted and the ENGINEER has determined that the new concrete cannot be incorporated integrally with the concrete previously placed.

2. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding.

3. Except where coated joint surfaces have been indicated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude.

4. Cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing.

5. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

6. Gravel

a. After the surfaces have been prepared, each approximately horizontal construction joint shall be covered with a 6-inch lift of a pea gravel mix.

b. The gravel mix shall be placed and spread uniformly.

c. Wall concrete shall follow immediately and shall be placed upon the fresh pea gravel mix.

C. Placement Interruptions

1. When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent WORK.

2. Such construction joints shall be made only where acceptable to the ENGINEER.

D. Embedded Items

1. No concrete shall be placed until the formwork, the installation of parts to be embedded, the reinforcement steel, and the preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before the placement of concrete.

2. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

3. Inserts or other embedded items shall conform to the indicated requirements.

4. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations as indicated or shown by Shop Drawings, and shall be acceptable to the ENGINEER before any concrete is placed.

5. Accuracy of placement shall be the responsibility of the CONTRACTOR.

E. Casting New Concrete Against Old Concrete

1. Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate.

2. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the ENGINEER.

F. Water

1. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes or other means, and carried out of the forms, clear of the WORK.

2. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set.

3. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete.

4. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to review by the ENGINEER.

G. Corrosion Protection

1. Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be positioned and supported prior to placement of concrete such that there will be a minimum of 2 inches clearance between said items and any part of the concrete reinforcement.

2. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

H. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall be provided, where practicable, during the placement of concrete.

I. Anchor bolts shall be accurately set and shall be maintained in position by templates while embedded in the concrete.

J. Cleaning: The surfaces of metalwork to be in contact with the concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

3.3 HANDLING, TRANSPORTING, AND PLACING

A. General

1. The placement of concrete shall conform to the applicable portions of ACI 301 and the indicated requirements.

2. No aluminum materials shall be used in conveying any concrete.

B. Non-Conforming WORK or Materials

1. Concrete which during or before placing is found not to conform to the indicated requirements will be rejected and shall be immediately removed from the WORK.

2. Concrete that is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.

C. Unauthorized Placement

1. No concrete shall be placed except in the presence of an authorized representative of the ENGINEER.

2. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of the placement of any concrete.

D. Placement in Wall and Column Forms

1. Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete.

2. In such cases, means such as hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation.

3. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4 feet in walls and 8 feet in columns.

4. Concrete shall be uniformly distributed during the process of deposition, and in no case after deposition shall any portion be displaced in the forms more than 6 feet in the horizontal direction.

5. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2 feet, and care shall be exercised to avoid inclined layers or inclined construction joints except where such are required for sloping members.

6. Each layer shall be placed while the previous layer is still soft.

7. The rate of placing concrete in wall forms shall not exceed 5 feet of vertical rise per hour.

8. Sufficient illumination shall be provided in the interior of forms such that the concrete at the places of deposit is visible from the deck or runway.

E. Casting New Concrete Against Old

1. An epoxy adhesive bonding agent shall be applied to the old surfaces according to the manufacturer's written recommendations.

2. This provision shall not apply to joints where waterstop has been provided.

3. Refer to Section 03 32 00 – Joints in Concrete, for other requirements.

F. Conveyor Belts and Chutes

1. Ends of chutes, hopper gates, and other points of concrete discharge throughout the CONTRACTOR's conveying, hoisting, and placement system shall be designed and arranged such that concrete passing from them will not fall separated into whatever receptacle immediately receives it.

2. Conveyor belts, if used, shall be of a type acceptable to the ENGINEER.

3. Chutes longer than 50 feet will not be permitted.

4. The minimum slopes of chutes shall be such that concrete of the indicated consistency will readily flow in them.

5. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted.

6. Conveyor belts and chutes shall be covered.

G. Placement in Slabs

1. Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement.

2. As the WORK progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

H. Temperature of Concrete

1. The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F.

2. For sections less than 12 inches thick, the temperature of concrete when placed shall be not less than 55 degrees F.

I. Hot or Cold Weather Procedures

1. If required by the ENGINEER, the CONTRACTOR shall submit detailed procedures for the production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather.

2. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

3. The CONTRACTOR shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

J. Hot Weather Placement

1. If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.

2. If the concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the CONTRACTOR shall employ effective means such as pre-cooling of aggregates, using ice as mixing water, or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.

3. During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

K. Cold Weather Placement

1. The placement of concrete shall conform to ACI 306.1 – Cold Weather Concreting, and the following requirements:

a. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed.

b. Before beginning concrete placement, thaw the subgrade to a minimum depth of 6 inches.

c. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

d. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.

e. Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.

3.4 PUMPING OF CONCRETE

A. General: If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. Pumping Equipment

1. The pumping equipment shall have 2 cylinders and shall be designed to operate with one cylinder in case the other one is not functioning.

2. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.

3. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.

4. Pumping equipment and hose conduits that are not functioning properly shall be replaced.

5. Aluminum conduits for conveying the concrete will not be permitted.

C. Field Control: Concrete samples for slump, air content, and test cylinders shall be taken at the placement end of the hose.

3.5 ORDER OF PLACING CONCRETE

A. General

1. The order of placing concrete in the WORK shall be acceptable to the ENGINEER.

2. In order to minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations.

B. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.

C. Concrete Surfaces

1. The surface of the concrete shall be level whenever a run of concrete is stopped.

2. For a level, straight, intermediate joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces.

3. The concrete shall be carried approximately 1/2 inch above the underside of the strip.

4. The strip shall be removed one hour after the concrete is placed, and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

3.6 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated, into a dense and homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete.

B. Vibrators

1. Vibrators shall be Group 3 in accordance with ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required.

2. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.

C. Waterstops

1. Care shall be exercised when placing concrete around waterstops.

2. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated.

3. Where flat-strip type waterstops have been placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated.

4. Concrete that is surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to ensure complete embedment of the waterstops in the concrete.

D. Concrete in Walls

1. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface.

2. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly.

3. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency has been placed in the forms.

4. The vibrating head shall not contact the surfaces of the forms.

5. Care shall be exercised not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.7 FINISHING CONCRETE SURFACES

A. General

1. Concrete surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface.

2. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions are defined as tolerances and shall be as indicated.

3. These tolerances are to be distinguished from irregularities in finish as indicated.

4. Aluminum finishing tools shall not be used.

B. Formed Surfaces

1. No treatment shall be required after form removal except for curing, repair of defective concrete, and treatment of surface defects.

2. Where architectural finish is required, treatment(s) shall be as indicated.

3. Surface holes larger than 1/2 inch in diameter or deeper than 1/4 inch are defined as surface defects in basins and exposed walls.

C. Unformed Surfaces

1. General

    a. After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools.

    b. Immediately after the concrete has been screeded it shall be treated with a liquid evaporation retardant, and the retardant shall be used again after each operation as necessary to prevent drying shrinkage cracks.

2. The classes of finish for unformed concrete surfaces are defined as follows:

    a. Finish U1

        1) Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8 inch.

        2) No further special finish is required.

    b. Finish U2

        1) After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades.

        2) Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted.

        3) Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture.

        4) Surface irregularities shall not exceed 1/4 inch.

        5) Joints and edges shall be tooled where indicated or as determined by the ENGINEER.

    c. Finish U3

        1) After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks.

        2) The finish shall be smooth and free of irregularities.

    d. Finish U4

        1) Trowel the Finish U3 surface to remove local depressions or high points.

        2) In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated.

        3) The resulting surface shall be sufficiently rough to provide a nonskid finish.

e. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	Finish
grade slabs and foundations to be covered with concrete or fill material	U1
floors to be covered with grouted tile or topping grout	U2
water bearing slabs with slopes 10 percent and less	U3
water bearing slabs with slopes greater than 10 percent	U4
slabs not water bearing	U4
slabs to be covered with built-up roofing	U2
interior slabs and floors to receive architectural finish	U3
top surface of walls	U3

3.8 ARCHITECTURAL FINISHES

A. General

1. Architectural finishes shall be provided only where specifically indicated below.

2. In other locations, the Paragraph entitled "Finishing Concrete Surfaces" shall apply.

Location	Finish
All exposed formed and unformed surfaces above grade, including the insides of all areas that hold fish.	Smooth Concrete Finish

B. Immediately after the forms have been stripped, the concrete surface shall be inspected and any poor joints, voids, rock pockets, or other defective areas shall be repaired and form-tie holes filled as indicated.

C. Architectural finishes shall not be applied until the concrete surface has been repaired as required and the concrete has cured at least 14 Days.

D. Architecturally treated concrete surfaces shall conform to the accepted example in texture, color, and quality, and it shall be the CONTRACTOR's responsibility to maintain and protect the concrete finish.

E. Smooth Concrete Finish

1. The concrete surface shall be wetted, and a grout shall be applied with a brush.

2. The grout shall be made by mixing one part Portland cement and one part of fine sand that will pass a No. 16 sieve, with sufficient water to give it the consistency of thick paint.

3. Cement used in the grout shall be 1/2 gray and 1/2 white Portland cement, or other proportion as determined by the ENGINEER.

4. White Portland cement shall be **Atlas White**, or equal.

5. Calcium chloride at 5 percent by volume of the cement shall be used in the brush coat.

6. Application

   a. The freshly applied grout shall be vigorously rubbed into the concrete surface with a wood float filling the small air holes.

   b. After the surface grout has been removed with a steel trowel, the surface shall be allowed to dry and, when dry, shall be vigorously rubbed with burlap to remove completely the remaining surface grout such that there is no visible paint-like film of grout on the concrete.

   c. The entire cleaning operation for any area shall be completed the same day it is started, and no grout shall be left on the surface overnight.

7. Operations

   a. Cleaning operations for any given day shall be terminated at panel joints.

   b. The various operations shall be carefully timed to secure the desired effect which is a light-colored concrete surface of uniform color and texture without any appearance of a paint or grout film.

8. In the event that improper manipulation results in an inferior finish, the CONTRACTOR shall rub such inferior areas with carborundum bricks.

9. Before beginning any of the final treatment on exposed surfaces, the CONTRACTOR shall treat in a satisfactory manner a trial area of at least 200 square feet in some inconspicuous place selected by the ENGINEER and shall preserve said trial area undisturbed until final completion.

3.9 CURING AND DAMPPROOFING

A. General: Concrete shall be cured for not less than 7 Days after placement, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
unstripped forms	1
construction joints between footings and walls, and between floor slab and columns	2
encasement and ductbank concrete and thrust blocks	3

concrete surfaces not specifically indicated in this Paragraph	4
floor slabs on grade in hydraulic structures	5
slabs not on grade	6
wall sections with forms removed	6

B. Method 1

1. Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal.

2. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed.

3. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6, below.

C. Method 2

1. The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed.

2. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3

1. The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed.

2. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of the concrete.

E. Method 4

1. The surface shall be sprayed with a liquid curing compound.

2. The compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.

3. Seal Protection

   a. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7-Day curing period.

   b. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

4. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, such compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

5. Application Schedule

    a. The curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms.

    b. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied.

    c. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

6. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6 feet of the joint and to any other location where the curing membrane has been disturbed.

7. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.

F. Method 5

1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow such that the surface is not marred or washed.

2. The concrete shall be given a coat of curing compound in accordance with Method 4, above.

3. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs.

4. Curing Blankets

    a. The curing blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3 inches, and fastened together with a waterproof cement to form a continuous watertight joint.

    b. The curing blankets shall be left in place during the 7-Day curing period and shall not be removed until after concrete for adjacent WORK has been placed.

    c. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections.

    d. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials will be permitted on the curing blankets.

    e. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket.

f. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain damp concrete surfaces.

G. Method 6

1. Method 6 shall apply to both walls and slabs.

2. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days, beginning immediately after the concrete has reached final set or the forms have been removed.

3. Until the concrete surface is covered with the curing mats, the entire surface shall be kept damp by applying water using nozzles that atomize the flow such that the surface is not marred or washed.

4. Curing Mats

a. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period.

b. The curing mats shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or other causes.

c. Edges shall be continuously held in place.

5. The curing mats and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

6. Immediately after the application of water has terminated at the end of the curing period, the curing mats shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4, above.

7. The CONTRACTOR shall dispose of excess water from the curing operation in order to avoid damage to the WORK.

3.10 PROTECTION

A. The CONTRACTOR shall protect the concrete against damage until final acceptance.

B. Weather Protection

1. Fresh concrete shall be protected from damage due to rain, hail, sleet or snow.

2. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.11 CURING DURING COLD WEATHER

A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F, provided that during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing has been temporarily discontinued.

B. Compound-Cured Concrete

1. Concrete that is to be cured by an application of curing compound shall require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces.

2. Otherwise, the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F.

C. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

D. Discontinuance of Protection

1. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours.

2. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F, provided that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

E. Artificial Heat

1. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying.

2. The use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound, provided that the use of curing compound for such surfaces is otherwise permitted.

3.12 TREATMENT OF SURFACE DEFECTS

A. General

1. Surface defects are defined in Finishing Concrete Surfaces, above.

2. As soon as forms are removed, the exposed concrete surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in order to secure a smooth, uniform, and continuous surface satisfactory to the ENGINEER.

3. Plastering or coating of surfaces to be smoothed will not be permitted.

4. No repairs shall be made until after inspection by the ENGINEER.

5. In no case will extensive patching of honeycombed concrete be permitted.

6. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below.

7. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced..

8. Repairs of surface defects shall be performed promptly.

B. Preparation

1. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area.

2. Feathered edges will not be permitted.

3. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance and soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast.

4. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar such that while the repair material is being applied the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends.

C. Materials

1. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand.

2. For exposed walls, the cement shall contain such a proportion of Atlas White Portland cement as is required to make the color of the patch match the color of the surrounding concrete.

D. Holes

1. Holes left by tie-rod cones shall be reamed with suitably toothed reamers in order to leave the surfaces of the holes clean and rough.

2. Holes then shall be repaired in an approved manner with dry-packed cement grout.

3. Holes left by form-tying devices having a rectangular cross section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

E. Repairs

1. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the indicated requirements, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures.

2. The surfaces of repaired concrete shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

F. Cracks: Prior to filling any structure with water, cracks shall be repaired to the satisfaction of the ENGINEER.

3.13 CARE AND REPAIR OF CONCRETE

A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until Final Acceptance.

B. Particular care shall be exercised in order to prevent the drying shrinkage damage of concrete and to avoid roughening or otherwise damaging the concrete surface.

C. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be repaired or removed and replaced with acceptable materials to the satisfaction of the ENGINEER.

END OF SECTION

SECTION 03 32 00 - JOINTS IN CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

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

B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

1.2 TYPES OF JOINTS

A. Construction Joints

1. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.

2. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or sealant groove of the shape indicated.

B. Contraction Joints

1. Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour.

2. The slab reinforcement shall be stopped 4-1/2 inches from the joint; which is provided with a sleeve-type dowel, in order to allow shrinkage of the concrete of the later pour.

3. Waterstop and/or sealant groove shall be provided where indicated.

C. Expansion Joints

1. In order to allow the concrete to expand freely, a space shall be provided between the 2 pours, and the joint shall be formed as indicated.

2. The space shall be obtained by placing a filler joint material against the earlier pour to act as a form for the later pour.

3. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a center-bulb type waterstop.

4. Provide premolded expansion joint material with the edge at the indicated distance below or back from the finished concrete surface.

5. Provide a slightly tapered, dressed and oiled wooden strip secured to or placed at the edge of the expansion joint during concrete placement and remove the strip later to form a space for the sealing material.

6. The space so formed shall be filled with a joint sealant material as indicated below. In order to keep the 2 wall or slab elements in line, the joint shall also be provided with a sleeve-type dowel as indicated.

D. Control Joints

1. The function of the control joint is to provide a weaker plane in the concrete where shrinkage cracks would likely occur.

2. Formed Groove

a. A groove, of the shape and dimensions indicated, shall be formed or saw-cut in the concrete and the groove shall then be filled with a joint sealant material.

b. The formed groove shall be placed in the first of the two sections cast at the control joint, in order to assure that the sealant bonds to the second section across the joint and not to the cement paste from the first pour.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Furnish placement drawings showing the location and types of joints for each structure.

2. Test Reports

a. Furnish certified test reports from the sealant manufacturer on the actual batch of material supplied, demonstrating compliance with the indicated requirements.

b. Furnish the test reports before using the sealant on the Project.

3. Welding Certification

a. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.

b. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the ENGINEER, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

4. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:

a. bearing pad

b. neoprene sponge

c. preformed joint filler

d. backing rod

e. waterstop

f. slip dowels

g. PVC tubing

C. Samples

1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.

2. Such samples shall be extruded or molded sections of each size or shape to be installed.

3. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples.

D. Certificates

1. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.

2. Supplier certificates will not be accepted.

1.4 QUALITY ASSURANCE

A. Waterstop Inspection

1. Waterstop field joints shall be subject to inspection, and no such WORK shall be scheduled or started without having made prior arrangements with the ENGINEER for the required inspections.

2. Provide not less than 24 hours notice for the scheduling of such inspections.

3. Field joints in waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point.

4. Defective field joints shall be replaced with material that passes inspection, and faulty material shall be removed from the Site and destroyed.

B. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. offsets at joints greater than 1/16 inch or 15 percent of material thickness at any point, whichever is less

2. exterior cracking at the joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness at any point, whichever is less

3. any combination of offset or exterior cracking that will result in a net reduction in the cross-section of the waterstop in excess of 1/16 inch or 15 percent of material thickness at any point, whichever is less

4. misalignment of the joint which results in misalignment of the waterstop in excess of 1/2 inch in 10 feet

5. porosity in the welded joint as evidenced by visual inspection

6. bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a penknife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

7. visible signs of separation when the cooled splice is bent by hand at any sharp angle

8. evidence of burned material

C. Waterstop Samples

1. Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted.

2. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided.

3. In addition, field samples of prefabricated fittings (crosses, tees, and the like) will be selected at random by the ENGINEER for testing by a laboratory at the OWNER's expense.

4. When tested, the tensile strength across the joints shall be at least 1120 psi for PVC waterstops.

D. Construction Joint Sealant

1. The CONTRACTOR shall prepare adhesion and cohesion test specimens at intervals of 5 Days while sealants are being installed.

2. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

   a. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch).

   b. Spacing between the blocks shall be one inch.

   c. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to set and hold sealant cross-sections of 1/2-inch by 2-inch with a width of one inch.

   d. The sealant shall be cast and cured in accordance with the manufacturer's recommendations, except that the curing period shall be not less than 24 hours.

e. Following the curing period, the gap between the blocks shall be widened to 1-1/2 inches, and spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.5 SPECIAL CORRECTION OF DEFECTS REQUIREMENT

A. The CONTRACTOR shall furnish a 5-year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that the CONTRACTOR agrees to repair or replace, to the satisfaction of the OWNER, any defective areas which become evident within the 5-year period.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Joint materials shall be listed as compliant with NSF Standard 61.

2.2 WATERSTOPS

A. PVC Waterstops

1. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the indicated requirements of this Section.

2. No reclaimed or scrap material shall be used.

3. The CONTRACTOR shall obtain from the waterstop manufacturer and shall furnish to the ENGINEER for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in the U.S. Army Corps of Engineers Specification CRD-C572-PVC Waterstops, and those indicated.

4. Flatstrip and Center-Bulb Waterstops

a. Flatstrip and center-bulb waterstops shall be manufactured such that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8 inch.

b. The waterstop shall be provided with hog rings installed at 12 inches on centers along the waterstop.

c. Shapes shall be as indicated, or as acceptable to the ENGINEER.

5. Multi-Rib Waterstops

a. Multi-rib waterstops shall be as indicated or as acceptable to the ENGINEER.

b. Prefabricated joint fittings shall be used at intersections of the ribbed-type waterstops.

6. Retrofit Waterstops

a. Retrofit waterstops and batten bars shall be as indicated or as acceptable to the ENGINEER.

b. The waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

7. When tested in accordance with the indicated test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	Value	ASTM Std
Tensile Strength-min, psi	2000	D 638, Type IV
Ultimate Elongation-min, percent	350	D 638, Type IV
Low Temp Brittleness, max degrees F	-35	D 746
Stiffness in Flexure, min, psi	600	D 747
Accelerated Extraction (CRD-C572		
Tensile Strength-min, psi	1500	D 638, Type IV
Ultimate Elongation, min, percent	300	D 638, Type IV
Effect of Alkalis (CRD-C572		
Change in Weight, percent	plus 0.25/minus 0.10	------
Change in Durometer, Shore A	plus and minus 5	D 2240
Finish Waterstop		
Tensile Strength-min, psi	1400	D 638, Type IV
Ultimate Elongation, min percent	280	D 638, Type IV

B. Preformed Hydrophilic Waterstop

1. Hydrophilic (bentonite-free) waterstops shall be **Hydro-Flex Waterstop** as manufactured by **Henry Co.**, or **Earthshield Type 23**, as manufactured by **JP Specialties**, or equal.

2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.

3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

4. The waterstop shall be manufactured from butyl rubber with hydrophilic properties.

5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.

6. The minimum expansion ratio of modified chloroprene shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).

7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

C. When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed in this Section.

2.3 JOINT SEALANT FOR WATER-BEARING JOINTS

A. The joint sealant shall be a polyurethane polymer designed for bonding to concrete which is continuously submerged in water.

B. No material will be accepted which has an unsatisfactory history as to bond or durability when used in the joints of water-retaining structures.

C. Joint sealant material shall meet the following requirements (73 degrees F and 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200-gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	175 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

D. Polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be 2-part polyurethane with the physical properties of the cured sealant conforming to or exceeding the requirements of ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2-part material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used, conforming to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.

3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I.

4. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore A hardness range of 35 to 45 shall be used.

5. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

E. Sealant Manufacturers

1. Sealants shall be **PSI-270** as manufactured by **Polymeric Systems Inc., Sikaflex 2C,** as manufactured by **Sika Corporation,** or equal.

F. Sealants for non-waterstop joints in concrete shall be in conformance with the requirements of Section 07 92 13 – Sealants and Caulking.

2.4 JOINT MATERIALS

A. Neoprene Sponge

1. The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C5-E1.

B. Joint Filler

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.

2. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.

3. Bituminous fiber type will not be accepted.

4. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.

2.5 BACKING ROD

A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.

B. The rod material shall be compatible with the joint sealant material and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.

C. The rod shall be 1/8 inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.6 SLIP DOWELS

A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

2.7 PVC TUBING

A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

PART 3 -- EXECUTION

3.1 GENERAL

A. Waterstops shall be embedded in the concrete across joints as indicated.

B. Waterstops shall be fully continuous for the extent of the joint.

C. Splices necessary to provide such continuity shall conform to the printed instructions of the waterstop manufacturer.

D. The CONTRACTOR shall take suitable precautions and provide means to support and protect the waterstops during the progress of the WORK and shall repair or replace any waterstops damaged during progress of the WORK at no additional cost to the OWNER.

E. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.

F. When any waterstop is installed in the concrete on one side of a joint while the other portion of the waterstop remains exposed to the atmosphere for more than 2 Days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure time until the exposed portion of waterstop is embedded in concrete.

3.2 SPLICES IN PVC WATERSTOPS

A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations.

B. It is essential that:

1. The material shall not be damaged by heat sealing.

2. The splices shall have a tensile strength of not less than 80 percent of the unspliced material.

3. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.

4. No edge welding will be accepted.

C. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

D. Other Joints

1. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop

sections, shall be prefabricated prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint.

2. Upon inspection and approval, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt-welded to the straight run portions of waterstop in place in the forms.

E. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.3 JOINT CONSTRUCTION

A. Setting Waterstops

1. In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken as to the correct positioning of the waterstops during installation.

2. Adequate provisions shall be made to support and anchor the waterstops during the progress of the WORK and to ensure proper embedment in the concrete.

3. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints.

4. The center axis of the waterstops shall be coincident with the joint openings.

5. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

B. Waterstop Placement

1. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed.

2. Waterstops shall be held in place with light wire ties on 12-inch centers, which shall be passed through hog rings at the edge of the waterstop and tied to the curtain of reinforcing steel.

3. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked.

4. In placing concrete around horizontal waterstops with their flat face in a horizontal plane, the concrete shall be worked under the waterstops by hand in order to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material.

D. Waterstop in vertical wall joints shall terminate 6 inches from the top of the wall, where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

E. Joint Location

1. Construction joints and other types of joints shall be provided where indicated.

2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.

3. Where joints are indicated to be spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing.

4. The location of joints, regardless of type, shall be submitted for acceptance by the ENGINEER.

F. Joint Preparation

1. Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.

2. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls.

3. Surfaces shall be prepared in accordance with Section 03 31 00 – Cast-in-Place Concrete.

G. Construction Joint Sealant

1. Construction joints in water-bearing floor slabs and elsewhere as indicated shall be provided with tapered grooves which shall be filled with a construction joint sealant.

2. The material used to form the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant.

3. After removing the forms from the grooves, laitance and fins shall be removed, and the grooves shall be sand blasted.

4. The grooves shall be allowed to thoroughly dry, after which they shall be blown out and immediately thereafter, they shall be primed and filled with the construction joint sealant.

5. The primer shall be furnished by the sealant manufacturer, and no sealant shall be used without a primer.

6. Care shall be used to completely fill the sealant grooves.

7. Areas designated to receive a sealant fillet shall be thoroughly cleaned as outlined for the tapered grooves prior to application of the sealant.

H. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application.

I. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant.

J. The sealant shall achieve final cure at least 7 Days before the structure is filled with water.

K. The sealant shall be installed by a competent waterproofing specialty contractor with a successful record of performance in similar installations.

L. Mixing

1. Catalyst-cured, 2-part materials shall be thoroughly, and uniformly mixed, and special care shall be taken to properly mix the sealer before its application.

2. Before any sealer is placed, the CONTRACTOR shall arrange to have workers performing the WORK carefully instructed on the proper method of mixing and application by a representative of the sealant manufacturer.

M. Failure to Cure

1. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the WORK shall be completely removed, and the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer.

2. The groove shall be re-sealed with the indicated joint sealant.

3. Costs of such removal, joint treatment, re-sealing, and appurtenant WORK shall be the CONTRACTOR’s responsibility as part of the WORK.

N. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is indicated, it shall be installed in accordance with the manufacturer's instructions and recommendations except as may be modified in this Section.

2. When requested by the ENGINEER, the CONTRACTOR shall arrange for the manufacturer to furnish technical assistance in the field.

3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided.

4. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of a non-intersecting joint.

5. Location

a. The hydrophilic waterstop shall be located as near as possible to the center of the joint, and it shall be continuous around the entire joint.

b. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

6. Placement

a. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete.

b. The groove shall be at least 3/4-inch-deep and 1-1/4 inches wide.

c. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2-1/2 inches.

7. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.

8. The hydrophilic waterstop shall not be installed where the air temperature falls below the manufacturer's recommended range.

9. Preparation

   a. The concrete surface under the hydrophilic waterstop shall be smooth and uniform, and the concrete shall be ground smooth if needed.

   b. Alternatively, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills voids and irregularities beneath the waterstop material.

   c. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

10. Securing

    a. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing.

    b. The above requirement shall be in addition to the adhesive recommended by the manufacturer.

END OF SECTION

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SECTION 03 35 11 – CONCRETE FLOOR FINISHES

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Surface treatments for concrete floors and slabs.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for concrete surface finishing to tolerance; floating, troweling, and similar operations; curing.

1.2 DEFINITIONS

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Mockups: Before casting concrete, build mockups to verify selections made under Sample submittals and to demonstrate typical joints, surface finish, tolerances, and standard of workmanship. Build mockups to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 -- PRODUCTS

2.1 DENSIFIERS AND HARDENERS

A. Products: Subject to compliance with requirements provide one of the following products or similar products:

1. US Spec; Permalith, www.usspec.com

B. LDH-1 (Liquid Densifier/Hardener) : Penetrating chemical compound that reacts with concrete, filling pores and dustproofing; for application to concrete prior to set.

1. Composition: Lithium silicate.

2.2 COATING

A. Products: Subject to compliance with requirements provide one of the following products or similar products:

1. US Spec; Hydrasheen 30% Sealer, www.usspec.com

2. SpecChem; Cure & Seal WB30, www.specchemllc.com

B. Sealed Concrete: Transparent, non-yellowing, water-based coating.

1. Composition: Acrylic polymer-based.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Verify that surface is free of conditions that may impede adhesion of products in accordance with manufacturer's requirements.

3.2 APPLICATION – GENERAL

A. Apply materials in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 03 60 00 - GROUTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents.

B. Grout provided as a base support for mechanical and electrical equipment shall conform to manufacturer's requirements and the requirements of this section.

C. The following types of grout are covered in this Section:

1. Non-Shrink Grout
2. High Strength Non-Shrink Grout
3. Non-Shrink Epoxy Grout
4. Topping Grout and Concrete/Grout Fill
5. Epoxy Adhesive for post-installed anchors and reinforcing bars

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

B. ASTM C307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

C. ASTM C531 – Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

D. ASTM C579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

E. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes

F. ASTM C827 – Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures

G. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

H. ASTM C1090 – Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout

I. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

J. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete

K. ASTM C1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use.

4. Documentation indicating that the grouts contain no chlorides or other chemicals that cause corrosion.

5. Manufacturer's Safety Data Sheet documenting composition of grouts.

6. Submit manufacturer's written warranty as indicated herein.

7. Name and telephone number of grout manufacturer's representative who will give on-site service. The representative shall have at least one year of experience with the indicated grouts.

1.4 QUALITY ASSURANCE

A. Field Tests

1. Compression test and performance evaluation specimens shall be taken from the first placement of each type of grout. The specimens shall be made by the Contractor's approved agency per 2015 IBC Section 1704.

2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout shall be performed in accordance with ASTM C1107.

3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill shall be performed in accordance with Section 03 31 00- Cast-in-Place Concrete.

4. Compression tests and fabrication of specimens for epoxy grouts shall be performed in accordance with ASTM C579, Method B. A set of 3 specimens shall be made for testing at 7 Days and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the CONTRACTOR including where test results show the grout to be defective. In such cases, the CONTRACTOR shall pay for the testing, removal and replacement of Defective Work, and re-testing, all as part of the WORK.

6. The CONTRACTOR shall assist the approved agency in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. Construction Tolerances: Construction tolerances shall be as indicated in Section 03 31 00 unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Non-Shrink Grouts

a. The grout manufacturer shall give a demonstration and training session for the cement based and epoxy non-shrink grouts to be used on the project before any installation of grout is allowed.

b. Training session shall use a minimum of 5 bags of cement-based non-shrink grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates to provide on-the-job training for the CONTRACTOR and ENGINEER. The CONTRACTOR employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.

c. The CONTRACTOR shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the ENGINEER.

1.5 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for WORK provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 -- PRODUCTS

2.1 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Beam and column (1 or 2 story) base plates less than 16-inches in the least dimension.	Non-Shrink
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink
Toppings and concrete/grout fill less than 3-inches thick	Topping Grout
Toppings and concrete/grout fill greater than 3-inches thick	Structural Concrete Per Section 03 31 00
Anchor bolts, anchor rods and reinforcing steel required to be set in epoxy or adhesive.	Post Installed Anchors in Concrete per Section 05 05 19, Rebar from 03 21 00

2.2 NON-SHRINK GROUTS

A. General

1. All non-shrink grout shall be cement based unless otherwise noted.

2. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

3. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each non-shrink grout shall be as recommended by the manufacturer for the particular application.

4. The manufacturer's product information shall state the acceptability of the non-shrink grout for the intended purpose and location.

5. Grout shall not contain chlorides or additives that may contribute to corrosion.

6. Grout placed in continuously wet environments or in exterior conditions shall not contain gypsum or calcium salt.

7. All cement-based non-shrink grout shall have the following general properties:

   a. Meet the requirements of ASTM C1107.

   b. Have a maximum early age height change of 4.0 percent expansion and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.

   c. No shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.

   d. A minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C882.

8. Environmental and ambient conditions shall be a factor in the selection of non-shrink grout. If a non-shrink grout is to be used in a high sulfate environment, marine environment, high temperature environment, or freeze/thaw environment, the manufacturer's product information shall state the acceptability for each environmental condition.

B. Non-Shrink Grout

1. Non-Shrink Grout shall have a minimum 28 Day compressive strength of 5000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. Non-Shrink Grout shall be **Five Star Grout** by **Five Star Products, Five Star Fluid Grout 100** by **Five Star Products, Sikagrout 212** by **Sika Corporation,** or approved equal.

2.3 TOPPING GROUT AND CONCRETE/GROUT FILL

A. Where fill thickness is 3-inches or greater, structural concrete as indicated in Section 03 31 00 - Cast-in-Place Concrete, may be used when accepted by the ENGINEER. Fiber reinforcing shall be as indicated below.

B. Grout for topping of slabs and concrete/grout fill for built-up surfaces of tanks, channels, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as indicated. Materials and procedures indicated for structural concrete in Section 03 31 00 - Cast-in-Place Concrete, shall apply unless indicated otherwise.

C. Topping grout and concrete/grout fill shall contain a minimum of 564 pounds of cement per cubic yard with a maximum water/cement ratio of 0.45.

D. Coarse aggregate shall be graded as follows:

U.S. Standard Sieve Size	Percent by Weight Passing
1/2 in	100
3/8 in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

E. Final mix design shall be as determined by trial mix design as indicated in Section 03 31 00, except that drying shrinkage tests are not required.

F. Topping grout and concrete grout/fill shall contain air-entraining agent per Section 03 31 00.

G. Strength: Minimum compressive strength of topping grout and concrete/grout fill at 28 days shall be 4500 psi.

H. Topping grout where the fill thickness is 3 inches or greater shall contain fiber reinforcing, unless otherwise shown on the Contract Documents. Fiber reinforcing shall be 100 percent virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 pounds per cubic yard of concrete. Fibers shall conform to ASTM C1116.

2.4 EPOXY ADHESIVE

A. Epoxy anchor adhesive shall coform to ASTM C881, Type IV, Class A, B, and C, Grade 3 with the exception of gel time.

B. Heat deflection temperature per ASTM D648 shall be a minimum 120 degrees F.

C. Adhesive shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The adhesive shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.

D. Epoxy anchor adhesive shall be capable of being used in submerged applications once cured.

E. Compressive strength per ASTM D695 shall be 10,000 psi minimum.

F. Whenever possible, overhead anchors, anchors in high fire risk areas, and anchors subject to working or operating temperatures above 200 degrees F shall be cast-in-place anchors. Whenever cast-in-place anchors cannot be used in these applications, use cement based non-shrink grout and oversized holes.

G. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar unless otherwise noted on the Contract Documents. Embedment shall not exceed 67 percent of the member depth.

H. Epoxy anchor adhexive shall be HIT-HY 200-A V3 by Hilti, SET-XP by Simpson Strong-Tie, Pure 110+ by Dewalt; or equal.

2.5 CURING MATERIALS

A. Curing materials shall be in accordance with Section 03 31 00 and as recommended by the manufacturer of prepackaged grouts.

2.6 CONSISTENCY

A. The consistency of grout shall be as necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

2.7 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.2 GENERAL

A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-site technical assistance within 72 hours of request, as part of the WORK.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 31 00. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.3 GROUTING PROCEDURES

A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted by the CONTRACTOR for acceptance by the ENGINEER.

3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

C. Topping Grout and Concrete/Grout Fill

1. Mechanical, electrical, and finish WORK shall be completed prior to placement of topping or concrete/grout fill. To ensure bonding to the base slab, the base slab shall be given an exposed aggregate finish. Alternatively, where accepted by the ENGINEER, the base slab shall be given a roughened textured surface by a close-spaced rake while the surface is green. After curing, high pressure washing shall

expose the aggregates and produce not less than a 3/16-inch amplitude roughness. Jackhammers or chipping hammers shall not be used.

2. The minimum thickness of grout topping and concrete/grout fill shall be one-inch. Where the finished surface of concrete/grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.

3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per the International Concrete Repair Institute (ICRI) -- Technical Guide for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays, prior to placing topping grout and grout fill. No topping grout shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

5. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.

6. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the ENGINEER, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.4 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

END OF SECTION

SECTION 05 05 19 – POST-INSTALLED ANCHORS IN CONCRETE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide post-installed anchors and appurtenances, complete and in place, as indicated in accordance with the Contract documents.

B. Unless otherwise indicated, drilled concrete anchors shall be adhesive anchors.

C. Section Includes:

1. Adhesive anchors
2. Expansion anchors
3. Screw anchors
4. Undercut anchors (dynamic loading)

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Definitions

1. Epoxy anchors are considered to be adhesive anchors.
2. Expansion anchors, screw anchors, and undercut anchors are considered to be mechanical anchors.

B. References

1. SBCC – Washington State Building Code Council, 2015 Edition
2. ACI 318 – Building Code Requirements for Structural Concrete (ACI 318-14) and Commentary
3. ACI 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary (ACI 350-20)
4. ACI 355.2 – Qualification of Post Installed Mechanical Anchors in Concrete and Commentary (ACI 355.2-19).
5. ASCE 7 – ASCE Standard ASCE/SEI 7-16 Minimum Design Loads for Buildings and Other Structures
6. ASCE 41-13 - ASCE Standard ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings
7. ICC ES AC 193 – Mechanical Anchors in Concrete Elements
8. ICC ES AC 308 –Post Installed Adhesive Anchors in Concrete Elements

1.3 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittal Procedures.

B. Submit the following:

1. Product data and technical information

2. Safety Data Sheets (SDS) for adhesives

3. Manufacturer's literature containing installation instructions and appropriate uses for each type of post-installed anchor and location of use

4. Current ICC-ES or IAPMO-UES Evaluation Reports

5. Certification for each installer demonstrating that they have been qualified in accordance with the Quality Assurance requirements below

C. No substitution for the indicated anchors will be considered unless accompanied with an ICC-ES or IAPMO-UES report verifying strength and material equivalency.

D. Complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be completed and submitted in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1. Where adhesive anchors are used for structural applications (such as dowels between new and existing concrete) and an embedment depth is not shown on the contract documents, the anchor shall be installed in accordance with Method 1 or Method 2 below:

a. Method 1: The minimum depth of embedment shall be greater than or equal to the development length (l_d) determined in accordance with ACI 318 for a cast in place reinforcing bar of the same diameter and grade, unless it can be shown by calculation that the anchor spacing and edge distance is sufficient to develop the tensile strength of the anchor in a lesser depth of embedment. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

b. Method 2: Adhesive anchors in concrete that cannot develop the tensile capacity of the steel element may be used to transfer forces, provided that the loads on the anchor are amplified by the system overstrength factor (Ω_o) in Table 12.2-1 of ASCE 7-10, or where unreduced forces are used in accordance with ASCE 41-13 for existing structures. Calculations shall be submitted in accordance with Section 01 33 00 – Submittal Procedures.

1.4 QUALITY ASSURANCE

A. Special inspection for all post-installed anchor installations shall be provided:

1. As recommended or required by the ICC-ES or IAPMO-UES report.

2. As required by the enforceable building code.

3. As otherwise indicated in the Contract Documents.

B. The most stringent of the above requirements shall be used. The cost of Special Inspection of post-installed anchors shall be paid for by the OWNER.

C. Before installing adhesive anchors in the WORK, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading if required.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

D. Before installing mechanical anchors in the WORK, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, and torqueing.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

E. Defective anchors noted by the Special Inspector shall be replaced and re-installed by the CONTRACTOR without any additional compensation.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged, complete with installation instructions.

B. Protect and handle materials in accordance with manufacturer’s recommendations to prevent damage or deterioration.

C. Anchoring adhesives shall be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

1.6 SITE CONDITIONS

A. Post-installed anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.

B. The anchor or fastener coating, plating, or steel type must provide suitable corrosion resistance for the environment in which the anchor or fastener is installed. Anchors, nuts, and washers in the locations listed below shall be fabricated from type 316 or 304 stainless steel:

1. buried locations

2. submerged locations

3. locations subject to seasonal or occasional flooding

4. inside hydraulic structures below the top of the structure

5. inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

6. chemical handling areas

7. inside trenches, containment walls, and curbed areas

8. locations indicated or designated by the ENGINEER to be provided with stainless steel anchors.

PART 2 -- PRODUCTS

2.1 ADHESIVE ANCHORS

A. General

1. The adhesive anchor system shall consist of: 1) adhesive product; and 2) threaded rod or reinforcing bar insert. The complete system shall be compatible as required by the adhesive manufacturer.

2. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the adhesive anchor for the intended purpose and location.

4. Adhesive anchors shall be permitted when regular ambient temperatures are consistent with manufacturer's recommendation for long and short term temperatures.

5. Adhesive anchors shall not be used where anchors are subject to vibration or fire.

6. Adhesive anchors shall not be used in overhead applications.

7. Where required, adhesive shall be capable of being used in submerged applications once cured.

B. Adhesive Anchors in Concrete

1. Threaded rod inserts shall meet the requirements of 05 50 00 - Miscellaneous Metalwork.

2. Reinforcing dowel inserts shall meet the material requirements of Section 03 21 00 – Reinforcement Steel and 03 31 00 – Cast-in-Place Concrete.

3. Adhesive for use in concrete adhesive anchors shall be certified for use in resisting seismic loads in cracked concrete applications in accordance with ICC-ES AC 308.

4. Where not detailed on the drawings, adhesive anchors shall be designed in accordance with ACI 350 as amended by the specific design provisions of ICC-ES AC 308.

5. Adhesive anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and shall have been tested and qualified for performance in cracked and uncracked concrete in accordance ICC-ES AC308 to resist static, wind, and earthquake (Seismic Design Categories A through F).

2.2 EXPANSION ANCHORS

A. General

1. Expansion anchors are post-installed torque-controlled mechanical expansion anchors used to resist structural loads.

2. Expansion anchors shall be an imperial sized, threaded stud with an integral cone expander, expansion clip, nut and washer.

3. Lead caulking anchors will not be permitted.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

5. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the expansion anchor for the intended purpose and location.

6. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Expansion Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318, which requires post-installed mechanical anchors to be qualified according to ACI 355.2.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Expansion anchors shall be Strong-Bolt 2 by Simpson Strong-Tie, Kwik-Bolt TZ by Hilti, Power-Stud+ SD1 by Powers Fasteners, or equal.

2.3 SCREW ANCHORS

A. General

1. Screw anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

2. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the screw anchor for the intended purpose and location.

3. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Screw Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ICC-ES AC193.

3. Screw anchors for concrete shall be Titen HD THDSS by Simpson Strong-Tie, or equal.

2.4 UNDERCUT ANCHORS

A. General

1. Undercut anchors are post-installed mechanical anchors that require pre-drilling and a special undercut notch configuration cut into the concrete before installation.

2. Self-undercutting anchors are post-installed torque-controlled mechanical anchors that cut their own undercut notch by application of a setting torque that forces a sleeve over a cone.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the undercut anchor for the intended purpose and location.

4. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

5. Undercut anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

B. Undercut Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Undercut anchors for concrete shall be HDA-TR or HDA-PR by Hilti, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Post-installed anchors shall be installed in strict accordance with the manufacturer's instructions, the ICC-ES or IAPMO-UES report, and project specific design requirements indicated on the Contract Documents or in the design calculations provided by the CONTRACTOR per Section 1.3.D.

B. Where holes are drilled in concrete, holes shall be accurately and squarely drilled, and the holes shall be cleaned in accordance with the manufacturer's recommendations.

C. Post-installed anchors shall not be installed until the concrete has reached the required 21 days or per manufacturer's requirements, whichever is longer.

D. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

E. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

F. The CONTRACTOR shall identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid

drilling through or cutting any existing reinforcing bars or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

G. Core drilling of holes is not allowed.

H. Identification of reinforcing steel and/or embedded items, relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of the WORK and shall be provided at no additional cost to the OWNER.

I. All abandoned drilled holes shall be repaired at no additional cost to the OWNER.

END OF SECTION

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SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. References herein to "Building Code" shall mean the International Building Code of the International Code Council (ICC). The edition of the codes adopted as of the date of award of this contract shall apply to the WORK herein.

B. Federal Specifications and Commercial Standards

AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 360	Structural Steel Buildings-Allowable Stress Design and Plastic Design
AISC	Allowable Stress Design Specifications for Structural Joints Using ASTM A325 and A490 Bolts approved by the Research Council on Structural Connections of the Engineering Foundation
ASTM A 36	Structural Steel
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 307	Carbon Steel Bolts and Studs
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
ASTM A 563	Carbon and Alloy Steel Nuts
ASTM A 572	High-Strength Low-Alloy Structural Steel
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
ASTM F 3125	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
AWS D1.1	Structural Welding Code – Steel

1.3 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details showing members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

C. Testing laboratory certifications for shop and field welders shall be submitted in triplicate directly to the ENGINEER with copies to the CONTRACTOR and others as required.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Structural steel

Wide Flange and Channel Shapes	ASTM A992
Other Shapes, Plates, Bars	ASTM A572 Grade 50
Pipe, Pipe Columns, Bollards	ASTM A53, Type E or S, Grade B standard weight unless noted otherwise
HSS	ASTM A500 Grade C

B. Bolts for connections shall be ASTM F3125 Grade A325, unless indicated otherwise. Bolts and nuts used to connect dissimilar metals shall be ASTM A193 and A194, respectively, Type 316 stainless steel.

C. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by **Nelson Stud Welding Company**, **Omark Industries, KSM Fastening Systems Division,** or equal.

D. Structural steel shall be cleaned and coated with System 100 amine cure epoxy in accordance with Section 09 96 00 - Protective Coating.

E. Steel members in contact with aluminum shall be galvanized per Section 05 50 00 - Miscellaneous Metalwork, unless indicated otherwise.

F. Structural members shall be furnished full length without splices unless otherwise indicated or approved by the ENGINEER.

2.2 INSPECTION AND TESTING

A. Shop inspection may be undertaken by the OWNER at its own expense. The CONTRACTOR shall give ample notice to the ENGINEER prior to the beginning of any fabrication so that inspection may be provided. The CONTRACTOR shall furnish facilities for the inspection of materials and workmanship in the shop, and inspectors shall be allowed free access to the necessary parts of the WORK. Inspectors shall have the authority to reject any materials or WORK that does not meet requirements. Inspection at the shop is intended as a means of facilitating the WORK and avoiding errors, but it is expressly understood that it will in no way relieve the CONTRACTOR from responsibility for proper materials or workmanship under this Specification.

B. The OWNER may engage inspectors to inspect welded connections and high-strength bolted connections, and to perform tests and prepare test reports.

1. Ten percent of all butt and bevel welds which extend continuously for 24-inches or less may be completely tested in accordance with AWS D1.1, Part E, Radiographic Testing of Welds, Chapter 6. Butt and bevel welds that extend continuously for more than 24-inches will be spot tested at intervals not exceeding 36-inches.

2. Defective welds shall be corrected or redone and retested at the CONTRACTOR's expense and to the satisfaction of the welding inspector.

3. The CONTRACTOR shall test to failure 3 bolts from each heat lot of bolts furnished to the job to verify compliance with this Specification. The testing laboratory shall be approved by the ENGINEER, and test reports shall be furnished to the ENGINEER in accordance with Section 01 33 00 – Contractor Submittals. In addition, high-strength bolts shall be inspected using one of the methods set forth in the AISC Specification "Structural Joints Using ASTM A 325 or A 490 Bolts."

C. The costs for initial testing will be paid by the OWNER. However, the CONTRACTOR shall pay testing costs for any additional testing and investigation on WORK that proves to be defective. The CONTRACTOR shall supply material for testing at no cost to the OWNER and shall assist the ENGINEER in obtaining material for test samples.

PART 3 -- EXECUTION

3.1 MEASUREMENT

A. The CONTRACTOR shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of WORK. The CONTRACTOR shall review the Drawings, and any discrepancies shall be reported to the ENGINEER for clarification prior to starting fabrication.

3.2 FABRICATION

A. Structural steel shall be fabricated in accordance with the Drawings, AISC Specifications, and the Shop Drawings.

B. Materials shall be properly marked and match-marked for field assembly.

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

3.3 CONNECTIONS

A. Shop and field connections shall be bolted or welded as indicated. Connections shall develop full strength of members joined and shall conform to AISC standard connections.

B. Unless otherwise indicated, welds shall conform to ANSI/AISC 360-16 Specification for Structural Steel Buildings.

3.4 WELDED CONSTRUCTION

A. The CONTRACTOR shall comply with the current AWS D1.1 Code for procedures, appearance, and quality of welds and welders, and methods used in correcting Defective

WORK. Welded architectural metal that is exposed to view shall have welds ground smooth. Shielded metal arc welding method or gas metal arc welding methods shall be used for welding structural steel.

B. Unless otherwise indicated, butt and bevel welds shall be complete penetration.

3.5 HOLES FOR OTHER WORK

A. Holes shall be provided as necessary or as indicated for securing other WORK to structural steel framing, and for the passage of other WORK through steel framing members. No torch cut holes will be permitted.

3.6 SHOP PAINT PRIMER

A. Shop paint primer shall be applied in accordance with Section 09 96 00 – Protective Coating. Omit shop-applied primer at field weld locations, for the portion of a member to be embedded in concrete, and where galvanizing with no further coating is required.

3.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

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

3.8 ERECTION

A. The CONTRACTOR shall comply with the AISC Specifications and Code of Standard Practice, and with indicated requirements.

B. High-strength bolts shall be installed in accordance with the AISC Specification for Structural Joints Using ASTM High-Strength Bolts. The connections shall be the friction type, unless indicated otherwise.

C. Anchor bolts and other connectors required for securing structural steel to inplace WORK and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the CONTRACTOR.

D. The CONTRACTOR shall be responsible for designing and installing any temporary bracing required for the safe erection of structural steel members.

3.9 SETTING BASES AND BEARING PLATES

A. Prior to the placement of non-shrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of all bond-reducing materials, and concrete and masonry bearing surface shall also be cleaned of all bond-reducing materials and be roughened to improve bonding.

B. Loose and attached baseplates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

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

D. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.10 FIELD ASSEMBLY

A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces that will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

3.11 MISFITS AT BOLTED CONNECTIONS

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

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

C. Correction of misfits is part of the WORK.

3.12 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the ENGINEER. Gas-cut sections shall be finished equal to a sheared appearance.

3.13 TOUCH-UP PAINTING

A. Immediately after erection, field welds, bolted connections, and abraded areas shall be cleaned of the shop paint primer. Touch-up paint primer applied by brush or spray shall be the same thickness and material as used for the shop coat. Galvanized surfaces that have been field welded or damaged shall be repaired in accordance with Section 05 50 00 – Miscellaneous Metalwork.

B. Finish coating of structural steel shall be as indicated in Section 09 96 00 – Protective Coating.

END OF SECTION

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SECTION 05 50 00 – MISCELLANEOUS METALWORK

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes

OSHA 1927.10	Fixed Ladders

B. Commercial Standards

AA-M32C22A41	Aluminum Assn.
AASHTO HS-20	Truck Loading
AISC	Manual of Steel Construction
AISI	Design of Light Gauge, Cold-Formed Steel Structural Members
ASTM A 36	Carbon Structural Steel
ASTM A 48	Gray Iron Castings
ASTM A 53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 193	Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service
ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing
ASTM F 1554	Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength

ANSI/AWS D1.1 Structural Welding Code - Steel

ANSI/AWS D1.2 Structural Welding Code - Aluminum

ANSI/AWS QC1 Qualification and Certification of Welding Inspectors

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.

2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

C. Grating

1. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.

2. Submit load and deflection tables for each style and depth of grating used.

D. Anchor Submittals

1. For post installed anchors in concrete other than powder-drive pins or impact anchors, refer to Section 05 05 19 – Post Installed Anchors in Concrete.

2. For powder-driven pins or impact anchors, complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be signed and stamped by a Professional Engineer registered in the state in which the project is located.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Steel

Wide Flange and Channel Shapes	ASTM A992
Other Shapes, Plates, Bars	ASTM A572 Grade 50

Pipe, Pipe Columns, Bollards	ASTM A53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A500 Grade C

B. Corrosion Protection

1. Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be coated in accordance with the requirements of 09 96 00 - Protective Coating System FM-8, and shall not be galvanized prior to coating.

2. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication.

C. Stainless Steel

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

D. Aluminum

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.

2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09 96 00 - Protective Coating.

E. Cast Iron

1. Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A 48, Class 50B, or better.

2.2 METAL STAIRS

A. Metal Stairs

1. Metal stairs shall be composed of steel or aluminum stringers and supports, shall be fabricated in accordance with the standard practice of the National Association of Ornamental Metal Manufacturers, and shall be as indicated.

2. Steel stair members shall be hot-dip galvanized after fabrication.

2.3 GRATING STAIR TREADS

A. Grating stair treads shall be designed to support a live load of 100 psf or a concentrated load at mid-span of 300 pounds, whichever creates the higher stress.

B. The maximum deflection due to the uniform live load shall be as required for metal grating, below.

C. Grating stair treads shall be provided with an integral non-slip nosing.

2.4 LADDERS

A. Materials

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be fabricated entirely of Type 316 stainless steel.

2. Other ladders shall be fabricated from carbon steel, hot-dip galvanized after fabrication

B. Pop-Up Extension

1. Every ladder that does not have an exterior handhold shall be equipped with a pop-up extension.

2. The pop-up extension device shall be manufactured of the same material and finish as the ladder, and shall be provided with a telescoping tubular section that locks automatically when fully extended.

3. Upward and downward improvement shall be controlled by stainless steel spring balancing mechanisms.

4. The units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.5 METAL GRATING

A. General

1. Metal grating shall be of the indicated design, size, and type.

2. Grating shall be supported around an opening by support members.

3. Where grating is supported on concrete, unless otherwise indicated provide embedded support angles that match the grating material and are mitered and welded at their corners.

4. Banding

a. The grating shall be completely banded at edges and cutouts.

b. The banding material and cross-section shall be equivalent to the bearing bars.

c. The banding shall be welded to each cut bearing bar.

5. The grating pieces shall be fastened to each support in 2 locations.

6. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing with a width equal to that of the stairway.

7. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of 1/4 inch or the span divided by 180, whichever is less.

8. Design Loading

   a. For standard duty plank and safety grating, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds.

   b. For heavy duty grating, the loading used for determining stresses and deflections shall be in accordance with AASHTO HS-20.

B. Material

1. Except where indicated otherwise, bar grating shall be fabricated entirely of:

   a. galvanized steel

2. Safety grating shall be fabricated from galvanized steel.

3. Plank grating shall be fabricated from galvanized steel.

4. Grating that may be partially or wholly submerged shall be fabricated entirely of Type 316 stainless steel

C. Standard-Duty Grating

1. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.

2. Standard duty grating shall be composed of serrated bar grating.

3. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.

D. Heavy-Duty Grating

1. Heavy-duty grating shall be fabricated from welded steel, galvanized after fabrication.

2. Crossbars shall be welded in position.

2.6 LEVEL-CONTROL WEIR PLATES

A. Level control weir plates shall be sized in accordance with ISO-1483/1-1990

B. Weir plates shall be fabricated from stainless steel.

2.7 HATCHES

A. Hatch shall be flush-type, unless indicated otherwise.

B. Hatches shall be fabricated from aluminum 5086 H34, 6063-T5 or 6061-T6, unless otherwise indicated.

C. Hatch hardware shall be fabricated from Type 316 stainless steel and shall be of the gutter-type.

D. The design live load shall be 300 psf, unless indicated otherwise. For metal decking in the headbox, design live load shall be 100 psf.

E. Configuration

1. Hatch opening sizes, number and swing direction of door leaves, and locations shall be as indicated.

2. Indicated sizes are for the clear opening.

3. Where the number of leaves is not indicated, openings larger than 42 inches in either direction shall be provided with double-leaf doors.

4. Unless indicated otherwise, hinges shall be located on the longer dimension side.

5. Unless indicated otherwise, ladder hatches shall be a minimum of 30 inches wide by 36 inches long, with the ladder centered on the shorter dimension and the door hinge opposite the ladder.

F. Door leaves shall be fabricated from a minimum of 1/4-inch thick checkered-pattern plate.

G. Channel or angle frames shall be fabricated from a minimum 1/4-inch material with an anchor flange around the perimeter.

H. Provide two hatch keys for each hatch secured to a 24" galvanized steel loop-to-loop aircraft cable lanyards.

I. Hatches shall be provided with an automatic hold-open arm with release handle. and shall be designed for easy opening from both inside and outside.

J. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter, a moat-type edge drain, and drain piping of the length and size necessary to remove the drain water from all dry spaces accessed by the hatch.

1. A joint gutter is not required for hatches in the metal decking for at the headbox for access to the UV units.

K. A minimum 1-1/2 inch diameter drain connection shall be provided, located by the manufacturer.

L. Hatches shall be **Bilco Type J, JD or KD, Babcock-Davis Type B-FGA, LW Products Model HD-SBS**, or equal.

2.8 CHECKERED PLATE

A. Checkered plate shall be provided with a pattern of raised lugs on one face, and shall be smooth on the opposite face.

B. Lugs

1. Lugs shall be a minimum of one inch in length and raised a minimum of 1/2 inch above the surface.

2. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions.

3. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

C. Where no material is indicated, the plates shall be fabricated from aluminum.

D. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to 1/4 inch, or the span divided by 240, whichever is less.

2.9 BOLTS AND ANCHORS

A. Standard Service (Non-Corrosive Application)

1. Bolts, anchor rods, anchor bolts, washers, and nuts shall be fabricated from steel as indicated.

2. Threads on galvanized bolts, rods and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.

3. Except as otherwise indicated, steel for bolt material, anchor rods, anchor bolts, and cap screws shall be in accordance with the following requirements:

a. Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized

b. Headed Anchor Rods and Anchor Bolts: ASTM F1554, Grade 36, hot-dip or mechanically galvanized with Grade A matching nuts

c. High-Strength Bolts, where indicated: ASTM A 325

d. Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

B. Corrosive Service

1. Bolts, anchor rods, anchor bolts, nuts, and washers in the locations listed below shall be fabricated from stainless steel as indicated.

a. buried locations, except pipe fittings and accessories

b. submerged locations

c. locations subject to seasonal or occasional flooding

d. inside hydraulic structures below the top of the structure

e. inside buried vaults, manholes, and structures that do not drain through a gravity drain pipe or to a sump with a pump

f. chemical handling areas

g. inside trenches, containment walls, and curbed areas

h. locations indicated or designated by the ENGINEER to be provided with stainless steel bolts

C. Unless otherwise indicated, stainless steel bolts, anchor rods, anchor bolts, nuts, and washers shall be fabricated from Type 316 stainless steel, Class 2, conforming to ASTM A 193 for bolts and to ASTM A 194 for nuts.

D. Coating

1. Threads on stainless steel bolts and rods shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.

2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

3. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

4. Antiseize lubricant shall be "PURE WHITE" by **Anti-Seize Technology,** Franklin Park, IL, 60131, **AS-470** by **Dixon Ticonderoga Company,** Lakehurst, NJ, 08733, or equal.

E. Bolt Requirements

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts.

3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.

4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.

6. Lock washers fabricated from material matching the bolts shall be installed where indicated.

7. The length of each bolt shall be such that the bolt extends at least 1/8 inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

F. Adhesive Anchors

1. General

a. Unless otherwise indicated, drilled concrete or masonry anchors shall be adhesive anchors.

b. No substitutions will be considered unless accompanied with a current ICC-ES or IAPMO-UES report verifying strength and material equivalency.

2. Epoxy Anchors

a. Epoxy adhesive anchors are required for drilled anchors for outdoor installations, in submerged, wet, splash, overhead, and corrosive conditions, and for anchoring handrails and reinforcing bars.

b. Epoxy shall be in accordance with the requirements of 03 60 00 - Grouting.

c. Threaded rod shall be galvanized for general purpose applications and fabricated from Type 316 stainless steel for use in corrosive applications.

d. Epoxy anchors shall not be permitted in areas where the concrete temperature is in excess of 100 degrees F or higher than the limiting temperature recommended by the manufacturer, whichever is lower.

e. Epoxy anchors shall not be used where anchors are subject to vibration or fire.

f. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

3. Unless otherwise noted, threaded rod shall be galvanized steel.

G. Expanding-Type Anchors

1. Expanding-type anchors, if indicated or permitted, shall be galvanized steel unless otherwise noted, shall be of the expansion type, and shall be **Simpson Strong-Tie Strong-Bolt 2** anchors, **Hilti Kwik-Bolt TZ anchors, Powers Power-Stud+ SD1 or SD2 anchors,** or equal.

2. Lead caulking anchors will not be permitted.

3. Minimum size shall be as indicated on the Contract Documents.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

H. Non-Shrink Grouted Anchors

1. Grouted anchors, if indicated or permitted, shall be grouted with a non-shrink cementitious grout in accordance with the manufacturer's recommendations.

2. Non-shrink grout material shall be Class B or C in accordance with Section 03 60 00 - Grouting

PART 3 -- EXECUTION

3.1 FABRICATION AND INSTALLATION REQUIREMENTS

A. **Fabrication and Erection:** Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. Aluminum Railings

1. Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork.

2. Exposed surfaces shall be free from defects or other surface blemishes.

3. Dimensions and conditions shall be verified in the field.

4. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned.

5. Electrolysis protection of materials shall be provided.

C. Unless otherwise indicated, provide a 1/2-inch drain line to the nearest floor drain for floor hatches.

3.2 WELDING

A. Method

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.

2. The qualification of the welders shall be in accordance with the AWS Standards.

B. Quality

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.

2. Weld reinforcement shall be as indicated by the AWS Code.

3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.

4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32 inch on the flat.

3.3 GALVANIZING

A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.

B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.

C. Bolts, anchor rods, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A 153.

D. Field Repairs

1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.

2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.

3. The coating shall be applied to at least 3 mils dry film thickness, and shall be **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, **Galvite** by **ZRC Worldwide**, or equal.

3.4 DRILLED ANCHORS

A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.

B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.

C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.

D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

E. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars.

F. All abandoned drilled holes shall be filled with Epoxy Anchor Grout.

END OF SECTION

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SECTION 05 52 00 - ALUMINUM RAILINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide component aluminum railing WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Include railing layouts, post locations, and spacings, gate locations, removable railing sections, connectors, construction details, manufacturer's engineering data, installation instructions, and product data.

C. Calculations: Engineering structural calculations for railings, handrail brackets, brackets, support flanges, and fasteners or anchors.

PART 2 -- PRODUCTS

2.1 SYSTEM DESIGN AND STRUCTURAL PERFORMANCE OF RAILING COMPONENTS

A. General: All railings and installation shall be in accordance with the manufacturer's published recommendations and specifications.

B. Code Requirements: Railings, guardrails, and handrails shall conform to the code requirements for the State-approved OSHA for industrial-commercial, non-public use unless otherwise indicated.

C. Loading Conditions: Railings and handrail brackets shall be capable of withstanding either of the following loading conditions without exceeding the allowable working stress of the material and without permanent deformation.

1. A 200 pound concentrated load applied to any point in any direction.

2. A 50 pound per linear foot loading applied perpendicular to the top rail.

D. The allowable working stress shall be 60 percent of the material yield stress for materials that are more than 3-inches from a weld and 40 percent of the yield stress for all materials within 3-inches of any weld.

2.2 MATERIALS

A. Rail Section: Railings and handrails shall be round tube and round picket and round pipedesign railing system unless otherwise indicated.

B. Rail Material: Aluminum shall be U.S. Alloy 6061 or 6063, T-5 or T-6. Aluminum pipe rail shall be not less than 1-1/2 inch diameter, Schedule 40 pipe.

C. Isolation from Concrete: Electrolysis protective material shall be in accordance with Section 09 96 00 - Protective Coating.

D. Sleeves: Sleeves shall be formed with galvanized steel. Sleeves for removable posts shall be of steel, hot-dip galvanized after fabrication. Galvanizing of steel sleeves shall be done after fabrication to prevent raw steel from being exposed to the elements.

E. Fasteners: Fasteners, screws, and bolts shall be concealed and shall be of stainless steel or aluminum. Handrail bracket fasteners and fasteners over water basins shall be of stainless steel.

F. Brackets: Handrail brackets shall be aluminum with a finish that matches the handrail or railing of which they are a part.

G. Kickplates: Kickplates shall be extruded (match railing system) aluminum of not less than 4 inches in height. Kickplates for pipe railing shall be a channel section for strength.

H. Grout: Non-shrink grout for handrail posts shall consist of an inorganic, non-metallic, premixed grout in accordance with Section 03 60 00-Grouting with a minimum 28 day compressive strength of 4,000 psi.

2.3 FINISHES

A. Pipe Railing System: Pipe railing system including handrails, railings, tube caps, and other miscellaneous parts of rails shall be provided with an Architectural Class I, 0.7-mil clear anodized finish, AA-M12.

2.4 SUB-ASSEMBLIES

A. Height Requirements: Top of upper railing shall be 42-inches above the working surface. Kickplates shall be installed not more than 1/4-inch off the working surface and shall be provided where indicated and/or required by codes or Reference Standards.

B. Round Sections: Round tube and round picket railings shall be sleeve mounted unless otherwise indicated. Posts shall be not less than 1-1/2 inch diameter, Schedule 40 pipe or 1-1/2 inch by 2-inches oval section. The posts shall be evenly spaced at not less than 4-feet nor more than 5-feet on centers. Field conditions may require some adjustment of spacing. Top rails and railings shall be not less than 1-1/2 inch OD pipe. Rails may be type with bottom enclosures. Bottom rails shall be not less than 1-1/2 inch OD pipe or 1-7/8 inch diameter extrusion with bottom enclosures. The top railings shall be as long as possible and the post shall not project through the top rails. Kickplate of picket rails shall be a specially extruded, snap-in bottom rail enclosure with kickplate or special extruded centered kickplate that is screw applied to bottom of the bottom rail.

C. Guardrails: Guardrails shall be a 2 rail system with equal open spaces between rails (and kickplate when required) with no open space larger than 21-inches as required by IBC.

2.5 MANUFACTURERS, OR EQUAL

A. Round Pipe Railings

1. **"C-V Pipe Rail"** by **CraneVeyor Corp.**

2. **"Wesrail"** by **Moultrie Manufacturing Co.**

B. Rectangular Tube and Square Picket Railings

1. **"Balustrade"** (or Picket) by **ATR Technologies, Inc.**

2. **"Railtec 400"** vertical bar railing by **CraneVeyor Corp.**

C. Round Tube and Round Picket Railings

1. **Oval-Tube Railing "1J"** (with bottom fillers) by **ATR Technologies, Inc.**

2. **"Baluster Railing",** by **CraneVeyor Corp.**

3. **"Wesrail"** by **Moultrie Manufacturing Co.**

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken packages, containers, or bundles bearing the label of the manufacturer.

B. Storage: All materials shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

3.2 COMPONENT SYSTEMS

A. Unless otherwise indicated, aluminum handrails and railings shall be component systems, installed complete and ready for use with all anchors, attachments, balusters, brackets, caps, fasteners, gates, posts, sleeves, trim, and all other related items required or necessary for the complete installation.

3.3 CRAFTSMANSHIP

A. WORK shall be performed by craftsmen experienced in the fabrication of architectural metalwork. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field in advance. Joints, junctions, miters, and butting sections shall be precision-fitted, with no gaps occurring between sections, and all surfaces shall be flush and aligned and without sharp edges.

3.4 ALIGNMENT

A. Extruded, case, molded, or bent work shall be straight with true edges. Railings and handrails shall be provided with continuous top rails, without post projections or other obstructions.

3.5 EXPANSION/CONTRACTION

A. Railings shall provide expansion joints in the railing at all expansion joints in the structure. In addition exterior railing systems shall provide for 1/4-inch expansion and contraction per 20 linear feet of railing, and interior railing systems shall provide for 1/8-inch expansion or contraction per 20 linear feet of railing. Expansion joints shall be carefully aligned and without sharp edges.

3.6 FASTENER FINISH

A. Stainless steel fasteners shall be painted to match adjacent aluminum finishes.

3.7 RAILING CONTINUITY AND END TREATMENT

A. Handrails and railings shall be designed to form a continuous run system with elbow turns and bends that do not have interferences with hand movement. Handrails shall be continuous for the full length of the stairs and landings. The handrails shall extend not less than 12-inches beyond the top and bottom risers. Whenever possible, the extension shall be at least 18-inches for the possible use by handicapped people. The ends of handrails shall be returned to wall or shall be terminated in newel posts or safety terminals. Newel posts and safety terminals may be used only when approved by the ENGINEER.

3.8 GATES AND REMOVABLE SECTIONS

A. Safety swing gates shall be self-closing, adjustable, industrial type as manufactured by Cotterman or equivalent. Gate shall be poder-coated, safety yellow, aluminum with stainless steel springs and mounting hardware. Fixed width, hot-dip galvanized or powder-coated steel gate, are acceptable if supplied to the required opening width. Gates shall meet OSHA requirements.

B. Removable handrail sections shall be provided where indicated. Removable railing hardware's color shall match that of the railing system of which it is a part.

C. Aluminum items in contact with concrete or steel or embedded in concrete shall be provided with an electrolysis protective material. The protective material shall be applied to the aluminum surface that will be in contact with the dissimilar material.

D. Handrail posts installed into sleeves shall be provided with weep holes between 1/2-inch and 1/4-inch above the finish deck for condensation drainage.

END OF SECTION

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preservative treated wood materials.

2. Fire retardant treated wood materials

3. Concealed wood blocking, nailers and supports as indicated, or otherwise required for securing other Work.

4. Miscellaneous wood nailers furring, and grounds as indicated, or otherwise required for securing other Work.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Dimensional Lumber: Comply with PS 20 and requirements of specified grading agencies.

1. If no species is specified, provide any species graded by a qualified grading agency the agency specified; if no agency is specified, provide lumber graded by any grading agency meeting the specified requirements.

2. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee, www.alsc.org and who provides grading service for the species and grade specified; provided lumber stamped and grade mark unless otherwise indicated.

B. Dimensional lumber fabricated from old growth timber is not permitted.

2.2 TREATED WOOD MATERIALS

A. Marking: Each piece of treated lumber shall bear the approval mark of an approved testing agency.

B. Kiln Drying: Kiln-dried lumber shall be treated with a water-borne preservative and shall have a maximum moisture content of 19 percent after treatment. Plywood shall have a maximum moisture content of 15 percent after treatment.

C. Pressure-Treated Lumber: Pressure-treat in accordance with AWPA C1 - Manual of Recommended Practice, Standard for Preservative Treatment by Pressure Process – All Timber Products. Preservative shall conform to American Wood Preservers Assn. P5 – Standard for Waterborne Preservatives. Creosote shall not be used.

D. Cuts: Wherever necessary to cut, notch, dap, drill, or frame treated lumber, newly cut or bored surfaces shall be treated with 2 heavy coats of the same preservative used in the original treatment. The minimum penetration depth shall be 1/4-inch.

E. Fire-Retardant Treated Lumber: Where required, fire-retardant treatment for lumber shall conform to the requirements of the governing building code and shall be redried after treatment in accordance with AWPA C1. Allowable values shall be adjusted in accordance with AFPA-NDS.

2.3 DIMENSIONAL LUMBER FOR CONCEALED APPLICATIONS

A. Size: Nominal sizes as indicated on Drawings, S4S.

B. Moisture Content: S-dry or MC19

C. Miscellaneous Framing, Blocking, Nailers, Grounds and Furring:

1. Lumber: S4S, No. 2 or Standard Grade

2. Boards: Standard or No. 3.

2.4 PLYWOOD

A. Panels for back-up boards behind telephone equipment, electrical equipment, or communication equipment shall be PS 1 A-D plywood, or medium density fiberboard, ¾ inch thickness with a flame-spread index of 25 or less, smoke index of 450 or less when tested in accordance with ASTM E84.

2.5 ROUGH HARDWARE

A. Anchors and Fasteners: Anchors and fasteners for securing wood items, unless otherwise indicated, shall be as follows:

1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153.

2. Drywall Screws: Bugle-head, hardened steel, power driven type.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Install plywood backing panels by fastening to studs with screws with edges over firm bearing. Space fasteners at maximum 24 inches on center. Coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

C. Work Coordination and Performance: The Contractor shall coordinate the subcontractors and trades doing related Work. Work of this section shall be carefully planned and laid out. Work shall be performed under the direction of a capable, experienced supervisor.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

G. Securely attach rough carpentry work to substrate by anchoring and fastening.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach wood blocking to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Attach wood roofing nailers securely to substrate to resist the designed outward and upward wind loads indicated on Drawings and in accordance with ANSI/SPRI ED-1, Tables A6 and A7.

3.3 INSTALLATION OF WOOD FURRING

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

END OF SECTION

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SECTION 06 41 16 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Cabinet hardware.
3. Plastic-laminate-clad countertops.
4. Accessories.
5. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.

C. Samples: For each exposed product and for each color and texture specified.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Manufacturer of products.

1.6 FIELD CONDITIONS

A. Environmental Limitations with Humidity Control: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

B. Architectural Woodwork Standards Grade: Custom.

C. Type of Construction: Frameless.

D. Door and Drawer-Front Style: Flush overlay.

E. High-Pressure Decorative Laminate: ISO 4586-3, grades as indicated or if not indicated, as required by quality standard.

F. Exposed Surfaces:

1. Plastic-Laminate Grade: VGS.
2. Edges: PVC tape, 0.018-inch minimum thickness, matching laminate in color, pattern, and finish.
3. Pattern Direction: As indicated.

G. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, ISO 4586-3, grade to match exposed surface.

H. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

I. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by laminate manufacturer's designations.

2.2 PLASTIC-LAMINATE-CLAD-COUNTERTOPS

A. Grade: Custom

B. High-Pressure Decorative Laminate: ISO 4586-3, Grade HGS.

C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. As indicated by manufacturer's designations.

D. Edge Treatment: 3.0-mm PVC edging.

E. Core Material: MDF.

F. Core Material at Sinks: MDF made with exterior glue or exterior-grade plywood.

G. Core Thickness: 3/4 inch.

1. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of core material laminated to top.

H. Backer Sheet: Provide plastic-laminate backer sheet, ISO 4586-3, grade to match exposed surface, on underside of countertop substrate.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Medium-Density Fiberboard (MDF): ANSI A208.2, Grade 130.
2. Softwood Plywood: DOC PS 1, medium-density overlay.

2.4 CABINET HARDWARE AND ACCESSORIES

A. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 135 degrees of opening, self-closing.

B. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

C. Wire Pulls: Back mounted, solid metal, 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.

D. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.

E. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.

F. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.

G. Drawer Slides: ANSI/BHMA A156.9.
1. Heavy-Duty (Grade 1HD-100 and Grade 1HD-200): Side mount.

a. Type: Full extension.
b. Material: Galvanized steel ball bearing slides.
c. Motion Feature: Push to open and Self-closing mechanism.

H. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

I. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

1. Satin Chromium Plated: ANSI/BHMA 626 for brass or bronze base; ANSI/BHMA 652 for steel base.

J. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Type I, waterproof type as selected by fabricator to comply with requirements.

1. Adhesive for Bonding Edges: Hot-melt adhesive.

2.6 FABRICATION

A. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

B. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Before installation, condition cabinets and countertops to humidity conditions in installation areas for not less than 72 hours.

B. Architectural Woodwork Standards Grade: Install cabinets and countertops to comply with quality standard grade of item to be installed.

3.2 INSTALLATION – CABINETS

A. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

B. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches o.c. with approved fasteners.

3.3 INSTALLATION – COUNTERTOPS

A. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.

1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

B. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.

1. Secure field joints in countertops with concealed clamping devices located within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten in accordance with manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

C. Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

D. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8-inch-in-96-inches variation from a straight, level plane.

E. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.

F. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

G. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches o.c. Remove protection at Substantial Completion.

END OF SECTION

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SECTION 06 80 00 – FISH REARING EQUIPMENT

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall furnish and install fish rearing equipment including the FRP fry tank, egg picking trough, Early Rearing Troughs, sorting unit, and fish release trough and appurtenances as shown and specified herein. Equipment shall be complete and operable for functions in accordance with the requirements of the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall submit complete shop drawings of all equipment and appurtenances for review in accordance with the Section 01 33 00 - Contractor Submittals.

PART 2 -- PRODUCTS

2.1 FRY TANK (F-1)

A. **General:** The CONTRACTOR shall provide one (1) 48-inch diameter fiberglass reinforced plastic fry tank. Tank rim height shall be 2-ft. Fry tank shall be mounted on a 5-ft by 5-ft fabricated aluminum skid with fork pockets per manufacturer's recommendation. See Section 05 50 00 Miscellaneous Metalwork for fabrication requirements.

B. **Standards:** Construction of tank shall be in accordance with ASTM D 4907 and ASTM D2563 and other accepted industry standards for raceway tank design.

C. **Design:** Fiberglass tank shall be constructed using the contact molded method. Tank sidewall thickness shall have a continuous taper not made of stepped thickness courses.

D. ACCESSORIES

1. Drain Box and Fine Screen

a. Fry tank shall be equipped with a 6-inch by 6-inch drain box with a removable skimmer screen. Screen shall consist of 1/8"x1" on 1/4" slot mesh with 43% open area.

b. Drain box shall have a bottom opening for 4" PVC drainpipe connection.

E. BOLTS, ANCHOR BOLTS, WASHERS, SUPPORTS, AND HOLD DOWN LUGS

1. The CONTRACTOR shall provide all bolts, anchor bolts, nuts, washers, and supports as required for all the plastic and fiber glass items specified in this Section, and in accordance with the requirements of the Manufacturers of the plastic and fiber glass items. All bolts, anchor bolts, washers, hold down lugs, and supports required in connection with the plastic or fiber glass items provided under the Section shall be of Type 304 or 316 stainless steel.

F. MATERIALS

1. See Section 43 40 10 – Fiberglass Reinforced Plastic Tanks for construction materials, construction, and workmanship.

G. **Manufacturer**: Reiff Manufacturing

2.2 EGG PICKING TROUGH (E-1)

A. **General:** The CONTRACTOR shall provide one (1) fiberglass reinforced plastic egg picking trough. The trough shall be free-standing and include openings for drain piping and guide slots for four (4) sets of perforated screens.

B. Trough support stands shall be fabricated of FRP or other material as recommended by the manufacturer.

C. **Manufacturer**: Reiff Manufacturing

2.3 EARLY REARING TROUGHS (ERT-1 TO ERT-10)

A. **General:** The CONTRACTOR shall provide ten (10) fiberglass reinforced early rearing troughs (ERTs). Eight (8) ERTs (ERT-2 to ERT-9) shall be nominally 25-ft long, 36-in tall, and 36-in wide. Two (2) ERTs (ERT-1 and ERT-10) shall be nominally 25-ft long, 48-in tall, and 48-in wide. The troughs shall be free-standing and include openings for drain piping and guide slots for seven (7) sets of perforated screens.

B. Each trough shall have 4-inch thick insulation.

C. **Manufacturer or approved equal**:

1. Reiff Manufacturing

2.4 SORTING UNIT

A. **General:** The CONTRACTOR shall provide one (1) sorting unit in the Fish Release Vault that is designed, manufactured, and installed to operate in accordance with the Contract Documents. The sorting unit shall have a single inlet that is 1-ft wide and two outlets that are 1-ft wide. The sorting unit shall be capable of directing fish to one outlet or the other via a manual diverter gate.

B. The diverter gate shall be fabricated such that there are no sharp edges that could harm fish. After fabrication, edges shall be ground smooth and removed of all burrs. The diverter gate shall seal such that water, debris, and fish are guided into the proper flume with no substantial leakage past the gate.

C. The diverter gate shall be operated by a manual handle mounted to a gate stem above the sorting unit. The operator handle shall fit within the vault access hatch and shall be accessible from above. Provide an operator extension that would allow the diverter gate to be turned without having the enter the vault.

D. The equipment shall be readily adaptable for installation and operation as shown in the Contract Documents. Equipment requiring change or modifications shall be discussed with the ENGINEER. The CONTRACTOR shall prepare and submit drawings showing the necessary changes for approval by the ENGINEER. Changes shall be made at the CONTRACTOR's expense and shall include mechanical and structural WORK.

E. Sorting unit connection to fish release vault chute shall be coordinated by the CONTRACTOR and manufacturer.

F. The sorting unit and supporting pipe, tubing, and structural shapes necessary to support the trough shall be Type 316 in accordance with the applicable portions of Section 05 50 00 – Miscellaneous Metals.

G. All edges shall be rounded and all welds shall be ground smooth.

H. Any aluminum used in the fabrication shall be alloy 6061 or 6063 T-5 or T-6.

2.5 FISH RELEASE VAULT CHUTE

A. **General:** The CONTRACTOR shall provide one (1) fiberglass reinforced plastic fish release trough that is designed, manufactured, and installed to operate in accordance with the Contract Documents. The trough shall have a flared inlet that is approximately 9-feet wide and a single outlet that is 1-ft wide connecting to the sorting unit assemlby. The trough shall be approximately 8.5-ft long from inlet to outlet, mounted on a slope, and shall have a wall height of 16-inches. At the upper end, the chute shall be sealed to the end wall to prevent fish and water leakage.

B. The trough shall have a separately cured, 20 mils thick, unreinforced isophthalic gel coat applied to both the inside and outside of the trough. Both interior and exterior gelcoats shall be UV stabilized by the manufacturer. All edges shall be ground smooth to prevent fish injuries.

C. The fish trough shall be designed to be compatible with the sorting unit. The CONTRACTOR and manufacturer shall coordinate all aspects of this assembly to ensure a secure and functional system, attachments, and compatibility with other related equipment.

D. Stainless steel pipe, tubing, and structural shapes necessary to support the trough shall be Type 316 in accordance with the applicable portions of Section 05 50 00 – Miscellaneous Metals.

E. Any aluminum used in the fabrication shall be alloy 6061 or 6063 T-5 or T-6.

F. **Manufacturer or approved equal**:

1. Reiff Manufacturing

PART 3 -- EXECUTION

3.1 FISH REARING EQUIPMENT

A. General: All fish rearing equipment shall be assembled in accordance with the manufacturer's instruction and as shown on the Drawings. The CONTRACTOR shall furnish and install all valves and piping in accordance with Division 40 and Division 43.

END OF SECTION

SECTION 07 13 26 - SELF-ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modified bituminous sheet waterproofing.
2. Protection course.

B. Related Requirements:

1. Section 07 21 00 "Thermal Insulation", for rigid insulation board acceptable for use as a protection board.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written installation instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Indicate special or termination conditions and interface with other materials.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Qualification Statements: For Installer.

C. Sample warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to frozen, damp, or wet substrates.

1. Do not apply waterproofing when snow, rain, fog, or mist is present.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.6 COORDINATION

A. Coordinate Work under this Section with adjacent concrete foundation work, including fill, under-slab vapor retarders, and under-slab insulation.

B. Coordinate requirements for concrete formwork to provide suitable substrate for waterproofing and to minimize penetrations through waterproofing.

C. Coordinate formwork and form bracing requirements for blindside sheet waterproofing. Coordinate restrictions on use of form ties and other components as necessary to eliminate or minimize penetrations through blindside sheet waterproofing.

1.7 WARRANTY

A. Manufacturer's Warranty:

1. Waterproofing Warranty: Manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

a. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet Waterproofing: Minimum 60-mil (1.5-mm) nominal thickness, self-adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4-mil- (0.10-mm-) thick, polyethylene-film reinforcement, and with release liner on adhesive side.

1. Basis of Design: Subject to compliance with requirements, provide; MiraDRI 860/861 by Carlisle Coatings and Waterproofing, www.carlisleccw.com, or a comparable product.
2. Physical Properties:

a. Tensile Strength, Membrane: 250 psi (1.7 MPa) minimum; ASTM D412, Die C, modified.
b. Ultimate Elongation: 300 percent minimum; ASTM D412, Die C, modified.
c. Low-Temperature Flexibility: Pass at minus 20 deg F (minus 29 deg C); ASTM D1970/D1970M.
d. Puncture Resistance: 60 lbf minimum; ASTM E154/E154M.
e. Water Absorption: 0.1 percent weight-gain maximum after 48-hour immersion at 70 deg F (21 deg C); ASTM D570.
f. Water Vapor Permeance: 0.05 perm (2.9 ng/Pa x s x sq. m) maximum; ASTM E96/E96M, Water Method.

g. Hydrostatic-Head Resistance: 200 ft. (60 m) minimum; ASTM D5385/D5385M.

3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.2 ACCESSORIES FOR WATERPROOFING

A. Furnish accessory materials as recommended in writing by waterproofing manufacturer for intended use and compatibility with sheet waterproofing.

B. Primer: Liquid primer as recommended in writing for substrate by sheet waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner as recommended in writing for substrate by sheet waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

F. Metal Termination Bars: Aluminum or stainless-steel bars, approximately 1 by 1/8 inch (25 by 3 mm), predrilled at 9-inch (229-mm) centers.

2.3 PROTECTION COURSE

A. Comply with requirements set forth in Section 07 21 00 “Thermal Insulation”.

2.4 MOLDED-SHEET DRAINAGE PANELS

A. Molded-Sheet Drainage Panel with Polymeric Film, Nonwoven-Geotextile Faced: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded-plastic-sheet drainage core; with a nonwoven, needle-punched geotextile facing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of waterproofing.

1. Verify that concrete has cured and aged for minimum time recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D4263.

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

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written installation instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.

D. Remove fins, ridges, mortar, and other projections.

E. Fill form tie holes, honeycomb, aggregate pockets, holes, and other voids.

F. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D4258.

1. Install sheet strips of width in accordance with manufacturer's written installation instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16-inch (1.6 mm).

G. Bridge and cover isolation joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips of widths in accordance with manufacturer's written installation instructions.

H. Corners: Prepare, prime, and treat inside and outside corners in accordance with manufacturer's written installation instructions.

1. Install membrane strips centered over vertical inside corners. Install 3/4-inch (19-mm) fillets of liquid membrane on horizontal inside corners and as follows:

a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.

I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions.

3.3 INSTALLATION OF MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Install modified bituminous sheets in accordance with waterproofing manufacturer's written installation instructions.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2-inch- (64-mm-) minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.

D. Horizontal Application: Apply sheets from low to high points of decks to ensure that laps shed water.

E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.

F. Seal edges of sheet waterproofing terminations with termination bar and sealant.

G. Roll waterproofing membrane to firmly adhere to substrate. Roll seams and terminations.

H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

I. Immediately install protection course with butted joints over waterproofing membrane.

3.4 INSTALLATION OF MOLDED-SHEET DRAINAGE PANELS

A. Place and secure molded-sheet drainage panels, with geotextile facing away from wall substrate, in accordance with manufacturer's written installation instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded-sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish reports to Architect.

3.6 PROTECTION, REPAIR, AND CLEANING

A. Protect waterproofing from damage and wear during remainder of construction period.

B. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

C. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

D. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

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SECTION 07 21 00 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Extruded polystyrene foam-plastic (XPS) board foundation insulation.
2. Glass-fiber blanket insulation.
3. Mineral-wool blanket insulation.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Extruded polystyrene foam-plastic (XPS) board foundation insulation.
2. Glass-fiber blanket insulation.
3. Mineral-wool blanket insulation.

1.3 INFORMATIONAL SUBMITTALS

A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.

1. Sign, date, and post the certification in a conspicuous location on Project site.

B. Product test reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 EXTRUDED POLYSTYRENE FOAM-PLASTIC (XPS) BOARD FOUNDATION INSULATION

A. Extruded Polystyrene Board Insulation, Type VII (ASTM C578)
1. Nominal Compressive Strength: 60-psi, ASTM D1621.
2. Water Absorption: 0.1, ASTM C272.
3. Vapor Permeance: 0.8 perms.
4. Fire/Smoke Characteristics:

a. Class A; Flame Spread: 25, Smoke Developed: <450, ASTM E84.

5. For use horizontally under slabs-on-grade and vertically against the exterior side of foundation walls, and slab edges.

6. Nominal R-Value: R5/inch at 75 degrees F., ASTM C518.

7. Basis of Design: Subject to compliance with requirements, provide Styrofoam Highload 60 XPS Foam Insulation from DuPont; www.dupont.com/building; or a comparable product by a qualified manufacturer.

2.3 GLASS-FIBER BLANKET INSULATION

A. Glass-Fiber Blanket Insulation, Unfaced: ASTM C665, Type I; passing ASTM E136 for combustion characteristics.

2.4 MINERAL-WOOL BLANKET INSULATION

A. Mineral-Wool Blanket Insulation, Unfaced: ASTM C665, Type I (blankets without membrane facing); consisting of fibers; complying with ASTM E136 for combustion characteristics.

2.5 ACCESSORIES

A. Insulation for Miscellaneous Voids:

1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.

B. Insulation Anchors, Spindles, and Standoffs: As recommended by manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.2 INSTALLATION OF FOUNDATION WALL INSULATION

A. Butt panels together for tight fit.

B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

C. Adhesive Installation: Install with adhesive or press into tacky waterproofing according to manufacturer's written instructions.

3.3 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
5. For wood-framed construction, install blankets according to ASTM C1320 and as follows:

a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Glass-Fiber Insulation: Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.
2. Detailing Foam Insulation for Voids: Apply in accordance with manufacturer's written instructions.

3.4 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07 26 00 - VAPOR RETARDERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Below-slab vapor retarders.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for under-slab vapor retarders.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Vapor retarders.

1.3 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Basis of Design Product: Stego Wrap 15-Mil Vapor Barrier by Stego Industries, LLC.

B. Multi-layer plastic extrusion of polyolefin resins complying with ASTM E1745 Class A, B, and C.

1. Water Vapor Permeance: 0.0086 perms per ASTM F1249.
2. Puncture Resistance: 2,266 grams per ASTM D1709.
3. Tensile Strength: 70.6 lbf/in. per ASTM D882.
4. Thickness: 15 mil.

2.2 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

PART 3 - EXECUTION

3.1 PREPARATION

3.2 INSTALLATION OF VAPOR RETARDERS

A. Install vapor retarders in accordance with manufacturer's instructions and recommendations for the application indicated on Drawings.

3.3 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Penetrations in fire-resistance-rated walls.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.

B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.4 INFORMATIONAL SUBMITTALS

A. Listed system designs.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.

1) UL in its online directory "Product iQ."
2) Intertek Group in its "Directory of Building Products."
3) FM Approvals in its "Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Description: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.

1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.

D. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, in accordance with ASTM E84.

E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

B. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

C. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

D. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION

SECTION 07 84 43 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire-resistance-rated construction.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines.

1.4 INFORMATIONAL SUBMITTALS

A. Listed System Designs: For each joint firestopping system, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

    a. Joint firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with Listed System Designs published by a qualified testing agency.

        1) UL in its online directory "Product iQ."
        2) Intertek Group in its "Directory of Building Products."

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems must accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

1. Provide products that, upon curing, do not re-emulsify, dissolve, leach, breakdown, or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture.
2. Provide firestop products that do not contain ethylene glycol.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.
1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

2.3 ACCESSORIES

A. Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.

B. General: Install joint firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

C. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

D. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.2 IDENTIFICATION

A. Wall Identification: Permanently label walls containing firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 ft. from end of wall and at intervals not exceeding 30 ft.

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.

6. Installer's name.

3.3 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections in accordance with ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

END OF SECTION

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Silicone joint sealants.
2. Nonstaining silicone joint sealants.
3. Urethane joint sealants.
4. Mildew-resistant joint sealants.
5. Acoustical joint sealants.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product data.

B. Samples: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Joint-sealant schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each type of acoustical joint sealant, for tests performed by manufacturer and witnessed by a qualified testing agency.

B. Field Quality-Control Reports: For field-adhesion-test reports, for each sealant application tested.

C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Warranty Documentation:

1. Manufacturers' special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 WARRANTY

A. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested in accordance with ASTM C1248.

B. Silicone, Nonstaining, S, NS, 100/50, NT: Nonstaining, single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

B. Urethane, S, NS, 100/50, T, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Uses T and NT.

C. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

2.5 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies in accordance with ASTM E90.

B. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.7 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material 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.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.

b. Glass.
c. Porcelain enamel.
d. Resilient base
e. Fiber Reinforced Plastic

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.2 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants in accordance with requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.

3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.

G. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

H. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 08 11 13 – STEEL DOORS AND FRAMES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide steel doors and frames and appurtenant WORK, complete, in place, and operational in accordance with the Contract Documents.

1.2 REFERENCES

A. ANSI/SDI A250.8-2023 Specifications for Standard Steel Doors and Frames (SDI-100).

1.3 ACTION SUBMITTALS

A. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

B. Certifications:

C. Shop Drawings: Complete Shop Drawings showing location and detail of installation.

1. Include details of core and edge construction, through-door louvers, vision panels, and trim for openings.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Steel doors and frames shall be provided by a single Manufacturer.

B. Steel doors and frames shall conform to ANSI A 250.8/SDI 100, except where more stringent requirements are indicated herein.

C. Fire Rated Openings:

1. Steel doors and frames required to be fire-rated shall bear UL labels indicating the applicable fire ratings. Designs and construction of such products shall have specific UL approval according to current procedures for the fire rating. Assemblies shall be constructed to comply with NFPA 80, and with other requirements indicated.

2. Steel doors and frame assemblies and components shall be compliant with positive pressure and S-label requirements. Steel doors and frames shall be coordinated with door hardware supplier to ensure that total opening installation is compatible with UL 10C and UBC 7-2.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 -- PRODUCTS

2.1 HOLLOW DOORS AND FRAMES

A. Manufacturer: Subject to compliance with requirements, manufacturers whose products may be incorporated into the work include but are not limited to the following:

1. Amweld International LLC
2. Ceco Door, (ASSA ABLOY)
3. Steelcraft, (ALLEGION)

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.38 deg Btu/F x h x sq. ft. (2.16 W/K x sq. m) when tested in accordance with ASTM C1363 or ASTM E1423.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.
b. Thickness: 1-3/4 inches.
c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
d. Edge Construction: Model 2, Seamless.

e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
f. Non-Fire-Rated Core: Manufacturer's standard insulation material to comply with STC performance requirements.

2. Fire-Rated Core: Manufacturer's standard vertical steel stiffener core for fire-rated doors.

B. Frames:

1. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.

2. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.

3. Construction: Full profile welded.

4. Exposed Finish: Unless otherwise noted, shop paint over primer per manufacturer's recommendations for application. Finish coat color per finish schedule on drawings.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Maximum-Duty Doors and Frames: ANSI/SDI A250.8, Level 4; ANSI/SDI A250.4, Level A

1. Doors:

a. Type: As indicated in the Door and Frame Schedule on Drawings.

b. Thickness: 1-3/4 inches.

c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A60 coating.

d. Edge Construction: Model 2, Seamless.

e. Edge Bevel: Provide manufacturer's standard beveled or square edges.

f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.

g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.

h. Non-Fire-Rated Core: Factory-applied polyurethane foam.

B. Frames:

1. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum A60 coating.

2. Construction: Full profile welded.

3. Exposed Finish: Unless otherwise noted, shop paint over primer per manufacturer's recommendations for application. Finish coat color per finish schedule on drawings.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.

2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.

3. Postinstalled Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

C. Material: ASTM A879, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008 or ASTM A1011; hot-dip galvanized in accordance with ASTM A153, Class B.

2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153.

E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.

G. Glazing: Comply with requirements in Section 08 80 00 "GLAZING."

2.7 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding.

2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule on Drawings, and templates.

1. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with square stops unless otherwise indicated.

2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.

3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.

4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.8 STEEL FINISHES

A. Paint Finish:

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and shop- or field-applied coatings despite prolonged exposure.

2. Top and Intermediate Coats: Manufacturer's standard lead- and chromate-free alkyd paint recommended by paint manufacturer for primer compatibility. Colors to be selected by Architect or as indicated on finish schedule in the Drawings.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

C. Where doors or frames are noted to be field-painted, paint doors and frames prior to installation in controlled conditions when possible and touch up after installation.

3.2 INSTALLATION

A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.

b. Install frames with removable stops located on secure side of opening.

2. Fire-Rated Openings: Install frames in accordance with NFPA 80.

3. Floor Anchors: Secure with post-installed expansion anchors.

4. Neatly fill exterior door frames with spray foam insulation prior to installation.

5. In-Place Concrete Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.

d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.

2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.

3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to the COR.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations with COR to determine if replaced or repaired door assembly installations comply with specified requirements. COR reserves the right of refusal on repairs.

E. Prepare and submit separate inspection report to COR for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.

3.4 FINISH REPAIRS

A. Prime-Coat Touchup: For field-painted doors or frames, immediately after unpacking, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

B. Touchup Painting: After installation, identify damaged finish paint areas and repair per paint manufacturer’s instructions, prior to substantial completion.

C. COR responsible for approving touch-up paint repairs. Contractor shall re-touch-up paint until COR approves the work.

END OF SECTION

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SECTION 08 36 13 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sectional-door assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

B. Shop Drawings: For each installation and for components not dimensioned or detailed in manufacturer's product data.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

B. Regulatory Requirements: Comply with provisions in the U.S. Department of Justice's "2010 ADA Standards for Accessible Design" the United States Access Board's "Architectural Barriers Act (ABA) Standards" ICC A117.1 applicable to sectional doors.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty periods listed below:

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Failure of components or operators before reaching required number of operation cycles.
c. Faulty operation of hardware.
d. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
e. Delamination of exterior or interior facing materials.

2. Warranty Periods:
a. Door Sections: warrants the door sections against defects in material and workmanship, and deterioration due to rust-through for ten (10) years from date of delivery to the original purchaser. Also warrants the door sections against delamination of the polyurethane foam insulation from the steel skins for ten (10) years from date of delivery to the original purchaser.
b. Hardware: warrants all hardware against defects in material and workmanship for one (1) year from date of delivery to the original purchaser.
c. Prorated Springs: warrants springs against defects in material and workmanship for one (1) year from date of delivery to the original purchaser. The limited warranty for special high-cycle springs is prorated by percentage of cycle use and must be determined using a non-resettable cycle counter.
d. Finish: warrants the post paint process (exterior only) against chipping, cracking, and/or peeling (losing adhesion), for a period of (5) five years from the date of delivery to the original purchaser. Fading and chipping, cracking, or peeling caused by dents or scratches are not covered under this warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Provide sectional doors that comply with performance requirements specified without failure from defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

B. Structural Performance, Exterior Doors: Capable of withstanding the design wind loads.

1. Design Wind Load: As indicated on Drawings.
2. Testing: In accordance with ASTM E330/E330M or DASMA 108 for garage doors and complying with DASMA 108 acceptance criteria.

C. Windborne-Debris Impact Resistance: Provide sectional doors complying with the following requirements:
1. Garage-Door Glazed Openings: Pass DASMA 115.

D. Seismic Performance: Provide sectional doors that withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. Component Importance Factor: 1.0.

2.2 SECTIONAL-DOOR ASSEMBLY

A. Steel Sectional Door: Provide sectional door formed with hinged sections and fabricated so that finished door assembly is rigid and aligned with tight hairline joints; free of warp, twist, and deformation; and complies with requirements in DASMA 102.

1. Subject to compliance with requirements, manufacturers whose products may be incorporated into the work include but are not limited to the following:

a. Clopay Corporation
b. Overhead Door Company
c. Raynor
d. Wayne Dalton

B. Operation Cycles: Door components and operators capable of operating for not less than 10,000 operation cycles. One operation cycle is complete when door is opened from closed position to the open position and returned to closed position.

C. U-Value: 0.16 or lower.

D. Steel Door Sections: ASTM A653/A653M, zinc-coated (galvanized), cold-rolled, commercial steel sheet with G60 (Z180) zinc coating.

1. Door-Section Thickness: 3 inches.
2. Section Faces:

a. Thermal-Break Construction: Provide sections with continuous thermal-break construction separating the exterior and interior faces of door.
b. Exterior Face: Fabricated from single sheets, not more than 24 inches high; with horizontal meeting edges rolled to continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove, weather- and pinch-resistant seals and reinforcing flange return.

1) Steel Sheet Thickness: 0.036-inch nominal coated thickness.
2) Surface: Manufacturer's standard ribbed and stucco embossed.

c. Interior Face: Enclose insulation completely within steel exterior facing and interior facing material, with no exposed insulation. Provide the following interior-facing material:

1) Zinc-Coated (Galvanized) Steel Sheet: With minimum nominal coated thickness of 0.018 inch.

3. End Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet not less than 0.064-inch nominal coated thickness and welded to door section.
4. Intermediate Stiles: Provide intermediate stiles formed from not less than 0.064-inch- thick galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches.
5. Section Reinforcing: Horizontal and diagonal reinforcement as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place. Ensure that reinforcement does not obstruct vision lites.

a. Bottom Section: Reinforce section with a continuous channel or angle conforming to bottom-section profile and allowing installation of astragal (weatherseal).
b. Hardware Locations: Provide reinforcement for hardware attachment.

6. Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free insulation of type indicated below:
a. Foamed-in-Place Insulation: Polyurethane, foamed in place to completely fill interior of section and pressure bonded to face sheets to prevent delamination under wind load.

E. Track: Manufacturer's standard, galvanized-steel, high-lift track system. Provide complete system including brackets, bracing, and reinforcement to ensure rigid support of ball-bearing roller guides.

1. Material: Galvanized steel, ASTM A653/A653M, minimum G60 (Z180) zinc coating.
2. Size: As recommended in writing by manufacturer for door size, weight, track configuration and door clearances indicated on Drawings.
3. Track Reinforcement and Supports: Provide galvanized-steel members to support track without sag, sway, and vibration during opening and closing of doors. Slot vertical sections of track spaced 2 inches apart for door-drop safety device.

a. Vertical Track: Incline vertical track to ensure weathertight closure at jambs. Provide continuous angle or intermittent jamb brackets, depending on site conditions, attached to track and wall.
b. Horizontal Track: Provide continuous reinforcing angle from curve in track to end of track, attached to track and supported at points by laterally braced attachments to overhead structural members.

F. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom top and jambs of door.

G. Windows: Manufacturer's standard window units of shape and size and in locations indicated on Drawings. Set glazing in vinyl, rubber, or neoprene glazing channel. Provide removable stops of same material as door-section frames. Provide the following glazing:
1. Insulating Glass Units: Manufacturer's standard.

H. Hardware: Heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless steel, or other corrosion-resistant fasteners, to suit door type.

1. Hinges: Heavy-duty, galvanized-steel hinges of not less than 0.079-inch nominal coated thickness at each end stile and at each intermediate stile, in accordance with manufacturer's written recommendations for door size.

a. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is impossible.

2. Rollers: Heavy-duty rollers with steel ball bearings in case-hardened steel races, mounted to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Match roller-tire diameter to track width.

a. Roller-Tire Material: Case-hardened steel.

3. Push/Pull Handles: Equip each door with galvanized-steel lifting handles on each side of door, finished to match door.

I. Locking Device:

1. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
2. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

a. Lock Cylinders: Cylinders complying with Section 08 71 00 "Door Hardware" requirements.
b. Keying: Keyed to building keying system.
c. Keys: Provide per Section 08 71 00 "Door Hardware" requirements.

3. Chain Lock Keeper: Suitable for padlock.

J. Counterbalance Mechanism:

1. Torsion Spring: Adjustable-tension torsion springs complying with requirements of DASMA 102 for number of operation cycles indicated, mounted on torsion shaft.
2. Cable Drums and Shaft for Doors: Cast-aluminum cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised.

a. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.

3. Cables: Galvanized-steel, multistrand, lifting cables.
4. Cable Safety Device: Include a spring-loaded steel or bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if lifting cable breaks.
5. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.
6. Bumper: Provide spring bumper at each horizontal track to cushion door at end of opening operation.

K. Motorized Door Operator:
1. Usage Classification: Light duty, up to 10 cycles per hour.

L. Metal Finish:

1. Factory Prime Steel Finish: Compatible with field-applied finish and in manufacturer's standard color.
2. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat.

a. Color and Gloss: As selected by Architect from manufacturer's full range. Custom color to match siding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; in accordance with manufacturer's written instructions.

B. Tracks:

1. Fasten vertical track assembly to opening jambs and framing with fasteners spaced not more than 24 inches apart.
2. Hang horizontal track assembly from structural overhead framing with angles or channel hangers attached to framing by welding or bolting, or both. Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment.

C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION

SECTION 08 51 13 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum windows.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes.

B. Shop Drawings:

1. Plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

1.3 INFORMATIONAL SUBMITTALS

A. Test and Evaluation Reports:

1. Product Test Reports: For each aluminum window, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Testing Agency Qualifications: An FGIA-accredited testing agency for testing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver aluminum windows to Project site in original, unopened packages and store them in accordance with manufacturer's written instructions. Protect aluminum windows against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Handle aluminum windows in a manner that prevents damage before, during, and after installation.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install aluminum windows outside of limits recommended in writing by manufacturer.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain aluminum windows from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: AW.
2. Minimum Performance Grade: 40.

C. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:

1. Thermal Transmittance (U-factor): As determined in accordance with NFRC 100:

a. Fixed Windows: Not more than 0.34 Btu/sq. ft. x h x deg F.
b. Operable Windows: Not more than 0.44 Btu/sq. ft. x h x deg F.

2. Solar Heat-Gain Coefficient (SHGC): As determined in accordance with NFRC 200:

a. Fixed Windows: Not more than 0.36.
b. Operable Windows: Not more than 0.36 as determined in accordance with NFRC 200.

3. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance in accordance with AAMA 1503, showing a CRF of not less than 66.

D. Thermal Movements: Provide aluminum windows, including anchorage, which allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F (67 deg C) ambient; 180 deg F (100 deg C) material surfaces.

E. Outdoor-Indoor Transmission Class (OITC): Rated for not less than 26 OITC when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

2.3 ALUMINUM WINDOWS

A. Basis of Design Products; Subject to compliance with requirements, provide OPTIQ AA 4325 Series Windows by Kawneer, fixed and outswing active, or a comparable product from a qualified manufacturer.

B. Provide manufacturer's standard aluminum window assemblies consisting of frames, sashes, glass, hardware, fasteners, and all components and accessories as required for a complete installation.

C. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Casement: Outswing.
2. Fixed.

D. Frames and Sashes: Aluminum extrusions of alloy, temper, and strength complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Broken Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

E. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered.

F. Insulating-Glass Units: ASTM E2190.

1. Glass: ASTM C1036, Type 1, Class 1, q3.

a. Tint: Clear.
b. Kind: Fully tempered.

2. Lites: Two.
3. Filling: Fill space between glass lites with argon.
4. Low-E Coating: Sputtered on second surface.

G. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.

H. Window Hardware: Casement, outswing.

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested in accordance with ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

    a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.

2. Hinges: Non-friction type, not less than two per sash.
3. Lock: Lever handle and cam-action lock with keeper.

I. Weather Stripping: Provide manufacturer's standard full-perimeter weather stripping for each operable sash unless otherwise indicated.

J. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Avoid exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.

B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

C. Panning Trim: Profiles in sizes and configurations indicated on Drawings.

D. Nail Fins: Manufacturer's standard mounting flanges with holes pre-punched for mechanical fasteners.

2.5 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: Full, inside for outswing. sashes.

B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.

C. Glass-Fiber Mesh Fabric: 20-by-20 (0.85-by-0.85-mm) or 20-by-30 (0.85-by-0.42-mm) mesh of PVC-coated, glass-fiber threads; woven and fused to form a fabric mesh resistant to corrosion, shrinkage, stretch, impact damage, and weather deterioration. Comply with ASTM D3656/D3656M.

1. Mesh Color: Manufacturer's standard.

2.6 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

E. Window Assemblies: Combination. Provide window units in configuration indicated on Drawings. Provide window frames, sashes, hardware, and other trim and components necessary for a complete, secure, and weathertight installation, including the following:

1. Combination and reinforcing mullions with interior and exterior trim.
2. Interior and exterior extension and trim.
3. Exterior head and sill casings and trim.

F. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA AMP 500 "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

A. Organic Coatings:

1. High-Performance Fluoropolymer Finish: Two coats complying with AAMA 2605, containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

a. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, air and weather barriers, and other built-in components to ensure weathertight window installation.

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

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Install windows and components to drain water passing joints and condensation to the exterior.

D. Separate aluminum from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

3.4 ADJUSTING

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

3.5 CLEANING AND PROTECTION

A. Clean exposed surfaces immediately after installing windows using manufacturer's written instructions. Avoid damaging finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces,

remove contaminants immediately in accordance with manufacturer's written instructions.

END OF SECTION

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SECTION 08 71 00 - DOOR HARDWARE

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 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding doors.
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Cylinders specified for doors in other sections.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

D. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run

concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Schedule (reference drawings) and the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

    a. Two Hinges: For doors with heights up to 60 inches.
    b. Three Hinges: For doors with heights 61 to 90 inches.
    c. Four Hinges: For doors with heights 91 to 120 inches.
    d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

    a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
    b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

    a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

    a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

B. Sliding and Folding Door Hardware: Hardware is to be of type and design as specified and should conform with ANSI/BHMA A156.14.

1. Sliding Bi-Passing Pocket Door Hardware: Provide complete sets consisting of track, hangers, stops, bumpers, floor channel, guides, and accessories indicated.

2. Bi-folding Door Hardware: Rated for door panels weighing up to 125 lb.

2.3 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

B. Coordinators: ANSI/BHMA A156.3 door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

2.4 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers: Per client standard.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. New System: Key locks to a new key system as directed by the Owner.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).

E. Construction Keying: Provide construction master keyed cylinders.

F. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.5 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Heavy duty mortise locks shall have a ten-year warranty.

2. Where specified, provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180-degree viewing angle with protective covering to prevent tampering.

3. Manufacturers: Per client standard.

B. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed.

1. Heavy duty cylindrical locks shall have a seven-year warranty.

2. Vertical Impact: Exceed 100 vertical impacts (20 times ANSI/BHMA A156.2 requirements).

3. Furnish with solid cast levers, standard 2 3/4” backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.

4. Locks are to be non-handed and fully field reversible.

5. Locksets to incorporate a free-wheeling lever design.

6. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.2 requirements to 12 million cycles.

7. Manufacturers: Per client standard.

2.7 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.8 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Heavy duty surface mounted door closers shall have a 25-year warranty.

C. Locations: Per Door Schedule (reference drawings).

2.9 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.

4. Protection Plates: ANSI/BHMA A156.6 protection plates (kick, armor, or mop), fabricated from the following:

    a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.

B. Locations: Per Door Schedule (reference drawings).

2.10 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

C. Overhead Door Stops and Holders: to be integrated with closers; see section 2.8.

D. Locations: Per Door Schedule (reference drawings).

2.11 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Locations: Per Door Schedule (reference drawings).

2.12 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.13 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection (Punch Report): Reference Division 01 Sections “Closeout Procedures”. Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.

1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 PRELIMINARY SAMPLE DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. RO - Rockwood
3. SA - SARGENT
4. OT - Other
5. RF - Rixson
6. PE - Pemko

Preliminary Sample Hardware Sets

Set: 25.04.40.5

Description: TYPICAL EXT. UTILITY

6	Hinge, Full Mortise	TA2314 (x NRP @ out-swing doors w/locks)	US32D	MK
1	Self latching top bolt only - Metal door	2805	US26D	RO
2	Door Closer	351 P10	EN	SA
2	Door Stop	466-RKW or OH stop where floor stop presents tripping hazard	Black	RO
1	Threshold	Per detail x FHSL14		PE
1	Rain Guard	346C x full frame width, omit @ overhangs		PE
2	Ext. Sweep	3452CNB		PE
1	Overlapping Astragal	357C		PE

Set: 55.05.50.5

Description: TYPICAL OFFICE

3	Hinge, Full Mortise	TA2714 (x NRP @ out-swing doors w/locks)	US26D	MK
1	Entry/Office Lock	10XG05 LL	US26D	SA
1	Wall Stop	406/409 as required	US26D	RO
3	Silencer	608-RKW		RO

Set: 55.65.64.5

Description: TYPICAL RESTROOM

3	Hinge, Full Mortise	TA2714 (x NRP @ out-swing doors w/locks)	US26D	MK
1	Privacy Lock	V21 8265 LNL	US26D	SA
1	Door Closer	1431 reg/par arm to suit location	EN	SA
1	Kick Plate	K1050 10"H BEV CSK	US32D	RO
1	Mop Plate	K1050 6"H BEV CSK	US32D	RO
1	Wall Stop	406/409 as required	US26D	RO
1	Gasketing	S88BL Width x Height		PE

Set: 55.65.66.5

Description: TYPICAL SHOWER

3	Hinge, Full Mortise	TA2714 (x NRP @ out-swing doors w/locks)	US26D	MK
1	Privacy Lock	V21 8265 LNL	US26D	SA
1	Concealed OH Stop, HD	1-X36	630	RF
1	Door Closer	1431 reg/par arm to suit location	EN	SA
1	Kick Plate	K1050 10"H BEV CSK	US32D	RO
1	Mop Plate	K1050 6"H BEV CSK	US32D	RO
1	Gasketing	S88BL Width x Height		PE

Set: 99.BO

Description: EXT OVERHEAD DOORS

1	Cylinder as req'd	To suit product requirements		OT
1	Balance of Hardware	By Door Manufacturer		OT

END OF SECTION

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SECTION 08 80 00 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass products.
2. Insulating glass.
3. Glazing sealants.
4. Glazing tapes.
5. Miscellaneous glazing materials.

1.2 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances to achieve proper safety margins for glazing retention under each design load case, load case combination, and service condition.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For glass.

B. Product test reports.

C. Sample warranties.

1.5 WARRANTY

A. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined in accordance with the IBC and ASTM E1300:

1. Design Wind Pressures: As indicated on Drawings.
2. Thermal Loads: Design glazing to resist thermal stress breakage induced by differential temperature conditions and limited air circulation within individual glass lites and insulated glazing units.

B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. U-Factors: Center-of-glazing values, in accordance with NFRC 100 and based on most current non-beta version of LBL's WINDOW computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
2. SHGC and Visible Transmittance: Center-of-glazing values, in accordance with NFRC 200 and based on most current non-beta version of LBL's WINDOW computer program.
3. Visible Reflectance: Center-of-glazing values, in accordance with NFRC 300.

2.2 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the IGCC.

D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than thickness indicated.

E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated,

provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.3 GLASS PRODUCTS

A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.

B. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

2.4 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified in accordance with ASTM E2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.

2. Perimeter Spacer: Thermally broken aluminum.

3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.5 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of industry colors.

2.6 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, recommended in writing by manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks:
1. Type recommended in writing by sealant or glass manufacturer.

D. Spacers:
1. Type recommended in writing by sealant or glass manufacturer.

E. Edge Blocks:
1. Type recommended in writing by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and in accordance with requirements in referenced glazing publications.

3.2 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Apply heel bead of elastomeric sealant.

F. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

Delete paragraph below if not applicable or revise to suit Project; below assumes fixed stop is located on exterior.

G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended in writing by gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

A. Immediately after installation, remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.

1. If, despite such protection, contaminating substances do contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

3.6 MONOLITHIC GLASS SCHEDULE

A. Clear Glass Type: Fully tempered float glass.

1. Minimum Thickness: 6 mm.
2. Safety glazing required.

3.7 INSULATING GLASS SCHEDULE

A. Low-E-Coated, Clear Insulating Glass Type:

1. Overall Unit Thickness: 1 inch.

2. Minimum Thickness of Each Glass Lite: 6 mm.
3. Outdoor Lite: Low-iron fully tempered float glass.
4. Interspace Content: Argon.
5. Indoor Lite: Low-iron fully tempered float glass.
6. Low-E Coating: Pyrolytic on third surface.
7. Safety glazing required.

END OF SECTION

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SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.

B. Related Requirements:

1. Section 07 92 00 “Joint Sealants” for acoustical joint sealants
2. Section 09 22 16 “Non-Structural Metal Framing” or interior non-load-bearing wall framing.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
1. Gypsum board, Type X.
2. Mold-resistant gypsum board.
3. Glass-mat, water-resistant backing board.
4. Interior trim.
5. Joint treatment materials.
6. Sound-attenuation blankets.

1.3 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated in accordance with ASTM E119 by an independent testing agency.

2.3 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

B. Manufacturers: Subject to compliance with requirements, manufacturers whose products may be incorporated into the work include but are not limited to the following:
   1. Georgia-Pacific Gypsum LLC
   2. National Gypsum Company
   3. U.S.G. Corporation

2.4 INTERIOR GYPSUM BOARD

A. Gypsum Board, Type X: ASTM C1396/C1396M.
   1. Thickness: 5/8 inch.
   2. Long Edges: Tapered.

B. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Basis of Design Product: ToughRock Fireguard X Mold-Guard gypsum board.by Georgia-Pacific Gypsum LLC.
   2. Core: 5/8 inch, Type X for walls. 1/2 inch for ceilings.
   3. Long Edges: Tapered.
   4. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.5 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
   1. Core: 5/8 inch, Type X.
   2. Mold Resistance: ASTM D3273, score of 10 as rated in accordance with ASTM D3274.

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, or plastic.
2. Shapes:

a. Cornerbead.
b. Expansion (control) joint.

2.7 JOINT TREATMENT MATERIALS

A. Tape, joint compound, and finishing compound shall comply with ASTM C 475, and shall be compatible with the gypsum board, as recommended by the gypsum board Manufacturer.

2.8 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
1. Type X: At all wall and ceiling locations except where indicated otherwise on Drawings.
2. Mold-Resistant Type: As indicated on Drawings. Locations indicated on Drawings shall include walls and ceilings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints at locations indicated on Drawings.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners, unless otherwise indicated.
2. LC-Bead: Use at exposed panel edges, unless otherwise indicated.
3. L-Bead: Use where indicated on Drawings.
4. U-Bead: Use where indicated on Drawings.

3.5 FINISHING OF GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and in accordance with ASTM C840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for FRP panels.
3. Level 3: Where indicated on Drawings.
4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Acoustical panels.
2. Metal suspension system.
3. Metal edge moldings and trim.

B. Related Requirements:

1. Section 07 92 00 “Joint Sealants” for acoustical joint sealants installed with acoustical panel ceilings.

1.2 ACTION SUBMITTALS

A. Product Data.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

A. Seismic Performance: Suspended ceilings to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Manufacturers: Subject to compliance with requirements, manufacturer’s whose products may be incorporated into the work include but are not necessarily limited to the following:
1. Armstrong Ceiling and Wall Solutions
2. Rockfon
3. USG Corporation

2.2 ACOUSTICAL PANELS

A. Acoustical Panel Standard: Manufacturer's standard panels in accordance with ASTM E1264.
1. Basis of Design Product: ULTIMA, by Armstrong Ceiling and Walls Solutions

B. Classification: Type IV; Form 2; Pattern E; Fire Class A.

C. Color: White.

D. Ceiling Attenuation Class (CAC): 35.

E. Edge/Joint Detail: Square.

F. Thickness: 3/4 inch.

G. Modular Size: 24 by 24 inches.

2.3 METAL SUSPENSION SYSTEM

A. Metal Suspension-System Standard: Manufacturer's standard, direct-hung, metal suspension system and accessories in accordance with ASTM C635/C635M.

B. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 (Z90) coating designation; with prefinished 15/16-inch-wide metal caps on flanges.

1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Cold-rolled steel.
5. Cap Finish: Factory painted white per manufacturer’s standard suspension system finish.

2.4 ACCESSORIES

A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

B. Seismic Clips: Manufacturer's standard seismic clips designed to secure acoustical panels in place during a seismic event.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

PART 3 - EXECUTION

3.1 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated.

B. Layout openings for penetrations centered on the penetrating items.

3.2 INSTALLATION

A. Install acoustical panel ceilings in accordance with ASTM C636/C636M, seismic design requirements, and manufacturer's written instructions.

B. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Do not use exposed fasteners, including pop rivets, on moldings and trim.

3.3 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform inspections.

1. Periodic inspection during the installation of suspended ceiling grids in accordance with ASCE/SEI 7.

END OF SECTION

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SECTION 09 65 16 - RESILIENT SHEET FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes Resilient Finish Products as follows:

1. Commercial bio-based polyurethane heterogeneous sheet with fiberglass.
2. Thermoset rubber wall base.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color, texture, and pattern specified, in manufacturer's standard size.

1. For heat-welding bead, manufacturer's standard-size Samples of each color required.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of resilient sheet flooring to include in maintenance manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store resilient sheet flooring, resilient base, and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer. Store rolls upright.

1.5 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer for the duration recommended by manufacturer.

B. Close spaces to traffic during resilient sheet flooring installation.

C. Close spaces to traffic for 48 hours after resilient sheet flooring installation.

D. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For resilient sheet flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 BIO-BASED POLYURETHANE HETEROGENEOUS SHEET FLOORING (RSF-1)

A. Manufacturers: Subject to compliance with requirements, provide; Innate + In Tandem, by ShawContract, or a comparable product by a manufacturer including but not limited to the following:

1. Armstrong Flooring Inc.

B. Product Standard: ASTM F1303.

C. Thickness: 0.098 inch.

D. Wearing Surface: Manufacturer standard for product indicated.

E. Sheet Width: 6.6 feet.

F. Seamless-Installation Method: Heat welded.

G. Style Number: 4219V.

H. Color/Pattern: Flax 19114

2.3 THERMOSET- RUBBER BASE (RB-1, RB-2)

A. Manufacturers: Subject to compliance with requirements, provide; Baseworks, by Johnsonite, or a comparable product by a manufacturer including but not limited to the following:
1. Flexco
2. Nora Systems
3. Roppe

B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).

1. Style and Location:
a. Style B, Cove.

C. Thickness: 0.125 inch.

D. Height: 4 inches for RB-1; 6 inches for RB-2.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed.

G. Inside Corners: Job formed.

H. Colors: 283 Toast.

2.4 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient sheet flooring manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient product and adhesive manufacturers to suit resilient products and substrate conditions indicated.
Resilient sheet flooring adhesive; Basis of Design: Shaw 4151

C. Seamless-Installation Accessories:

1. Heat-Welding Bead: Manufacturer's solid-strand product for heat welding seams.

a. Colors: Shaw 270VS.

D. Floor Polish: Provide protective, liquid floor-polish products recommended by resilient product manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient sheet flooring and wall base.

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

3.2 PREPARATION

A. Prepare substrates according to resilient sheet flooring manufacturer's written instructions to ensure adhesion of resilient sheet flooring.

B. Concrete Substrates: Prepare according to ASTM F710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by resilient sheet flooring manufacturer. Do not use solvents.

3. Alkalinity and Adhesion Testing: Perform tests recommended by resilient sheet flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

    a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.

C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient sheet flooring until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.

E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient sheet flooring.

3.3 RESILIENT SHEET FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient sheet flooring.

B. Unroll resilient sheet flooring and allow it to stabilize before cutting and fitting.

C. Lay out resilient sheet flooring as follows:

1. Maintain uniformity of flooring direction.
2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
3. Match edges of flooring for color shading at seams.
4. Avoid cross seams.

D. Scribe and cut resilient sheet flooring to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

E. Extend resilient sheet flooring into toe spaces, door reveals, closets, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on resilient sheet flooring as marked on substrates. Use chalk or other nonpermanent marking device.

G. Install resilient sheet flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.

H. Adhere resilient sheet flooring to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

I. Seamless Installation:

1. Heat-Welded Seams: Comply with ASTM F1516. Rout joints and heat weld with welding bead to fuse sections permanently into a seamless flooring installation. Prepare, weld, and finish seams to produce surfaces flush with adjoining flooring surfaces.
2. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.

3.4 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

    a. Miter or cope corners to minimize open joints.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.

B. Perform the following operations immediately after completing resilient products installation:

1. Remove adhesive and other blemishes from surfaces.
2. Sweep and vacuum surfaces thoroughly.

3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, adhesive, and blemishes from flooring surfaces before applying liquid floor polish.

1. Apply coat(s) as recommended by product manufacturer.

E. Cover resilient products until Substantial Completion.

END OF SECTION

SECTION 09 68 13 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modular carpet tile.

B. Related Requirements:

1. Section 09 65 13 "RESILIENT BASE AND ACCESSORIES" for resilient wall base and accessories installed with carpet tile.

1.2 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 “Submittals” and below.

B. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.

C. Sustainable Design Submittals:

1. Include Volatile Organic Compounds (VOC) data for verification of compliance with Section 01 81 13 “SUSTAINABILITY DESIGN REQUIREMENTS”.

D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.

E. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

F. Sustainable Product Certification: Provide ANSI/NSF 140 certification for carpet products.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 10 percent of amount installed for each type indicated.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Carpet and Rug Institute's CRI 104.

1.8 FIELD CONDITIONS

A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.9 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, the following:

a. More than 10 percent edge raveling, snags, and runs.
b. Dimensional instability.
c. Excess static discharge.
d. Loss of tuft-bind strength.
e. Loss of face fiber.
f. Delamination.

PART 2 - PRODUCTS

2.1 CARPET TILE (CPT-1)

A. Location: Indicated on the Finish Schedule.

B. MFR, Pattern, and Color: Interface, Open Air 402, 106741 Nickel.

C. Size: 9.8 in x 39.4”.

D. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment that protects carpet:

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.

1. Comply with requirements for Volatile Organic Compounds (VOC) indicated in Section 01 81 13 “SUSTAINABILITY DESIGN REQUIREMENTS”

C. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

B. Examine carpet tile for type, color, pattern, and potential defects.

C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 03 30 00 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.

1. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.

a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft.in 24 hours.
b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.

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

3.2 PREPARATION

A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes, and depressions 1/8 inchwide or wider, and protrusions more than 1/32 inchunless more stringent requirements are required by manufacturer's written instructions.

C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye-lot integrity. Do not mix dye lots in same area.

D. Maintain pile-direction patterns indicated on Drawings and if not indicated as recommended in writing by carpet tile manufacturer.

E. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, non-staining marking device.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with the Carpet and Rug Institute's CRI 104, Section 13.7.

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 09 68 13

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SECTION 09 72 00 - WALL COVERINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vinyl wall coverings.

1.2 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 “Submittals” and below.

B. Product Data: For each type of product.

1. Include data on physical characteristics, durability, fade resistance, and fire-test-response characteristics.

C. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement seams and termination points.

D. Samples: Provide sample for each type of wall covering and for each color, pattern, texture, and finish specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For wall coverings to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with requirements for Volatile Organic Compounds (VOC) indicated in Section 01 81 13 “Sustainability Design Requirements

1.5 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and HVAC system is operating and maintaining ambient temperature and humidity conditions at levels intended for occupants after Project completion during the remainder of the construction period.

B. Lighting: Do not install wall covering until lighting that matches conditions intended for occupants after Project completion is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates in accordance with test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 50 or less.

2.2 VINYL WALL COVERING (WC-1)

A. Fabrics: Basis of Design products are indicated on the Finish Schedule. Subject to compliance with requirements, provide fabrics indicated, or a comparable product by a qualified manufacturer.

B. Description: Provide vinyl products in rolls from same production run and complying with the following:

1. FS CCC-W-408D for Type II, Medium Duty.

C. Width/Height: Manufacturer’s standard panel width for materials selected. Heights indicated on the Finish Schedule and Interior Elevations.

D. Backing: Manufacturer’s standard backing material for fabrics selected.

E. Mildew Resistance: Rating of zero or 1 when tested in accordance with ASTM G21.

F. Features:

1. Stain-Resistant Coating.
2. Antimicrobial.

3. Water-based inks.
4. Phthalate free.
5. Heavy-metals free.
6. Halogenated-fire-retardant free.

G. Colors, Textures, and Patterns: As indicated on Finish Legend on Drawings.

2.3 ACCESSORIES

A. Adhesive: Mildew-resistant, non-staining adhesive, for use with specific wall covering and substrate application indicated and as recommended in writing by wall-covering manufacturer.

1. Comply with requirements for Volatile Organic Compounds (VOC) indicated in Section 01 81 13 “SUSTAINABILITY DESIGN REQUIREMENTS”.

B. Primer/Sealer: Mildew resistant, complying with and recommended in writing by primer/sealer and wall-covering manufacturers for intended substrate.

C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended in writing by wall-covering manufacturer.

1. Comply with requirements for Volatile Organic Compounds (VOC) indicated in Section 01 81 13 “SUSTAINABILITY DESIGN REQUIREMENTS”.

D. Seam Tape: As recommended in writing by wall-covering manufacturer.

E. Trim: As indicated in Interior Details.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation surfaces being true in plane and vertical and horizontal alignment, maximum moisture content, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, and mildew.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   1. Gypsum Board: Apply primer/sealer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

D. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

E. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

3.3 INSTALLATION OF WALL LINER

A. Install wall liner, without gaps or overlaps. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.4 INSTALLATION OF WALL COVERING

A. Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated.

B. Cut wall-covering strips in roll number sequence. Change the roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install wall covering without lifted or curling edges and without visible shrinkage.

E. Install seams vertical and plumb at least 6 inches from outside corners and 6 inches from inside corners unless a change of pattern or color exists at corner. Horizontal seams are not permitted.

F. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without overlaps or gaps between strips.

G. At seam locations, paint 6-inch-wide section of wall substrate with a color to match the wallcovering background color.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

3.5 CLEANING

A. Remove excess adhesive at seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION

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SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Primers.
2. Water-based finish coatings.

B. Related Requirements:

1. Section 03 35 11 “Concrete Floor Finishes” for surface treatments for concrete floors and slabs

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.3 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers whose products may be incorporated into the work include but not limited to the following:
1. The Sherwin-Williams Company
2. PPG Paints
3. Benjamin Moore Paints

2.2 PAINT PRODUCTS, GENERAL

A. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

B. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Colors: As indicated in a color schedule.

2.3 PRIMERS

A. Interior, Institutional Low-Odor/VOC Primer Sealer: Water-based primer sealer with low-odor characteristics and a VOC of less than 10 grams per liter for use on new interior gypsum wallboard surfaces that are subsequently to be painted with latex finish coats.

1. Basis of Design Product: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer

B. Water-Based Bonding Primer: Water-based, low-odor acrylic primer formulated to promote adhesion of subsequent specified coatings.

1. Basis of Design Product: Rust-Oleum Sierra Performance Griptec Acrylic Primer.

2.4 WATER-BASED FINISH COATS

A. Interior, Latex, Institutional Low Odor/VOC, Eggshell: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.

1. Gloss and Sheen Level: Manufacturer's standard eggshell finish.
2. Basis of Design Product: Sherwin-Williams ProMar 200 Zero VOC Interior Latex.

B. Interior, Latex, Institutional Low Odor/VOC, Satin: White or colored latex paint with low-odor characteristics and a VOC of less than 10 grams per liter, for use in areas, such as hospitals and other occupied buildings, where the odor and VOC levels of conventional latex products would preclude their use.

1. Gloss and Sheen Level: Manufacturer's standard low-sheen finish.
2. Basis of Design Product: Sherwin-Williams ProMar 200 Zero VOC Interior Latex.

C. Interior, Latex, High-Performance Architectural Coating, Eggshell: High-performance architectural latex coating providing a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.

1. Gloss and Sheen Level: Manufacturer's standard eggshell finish.
2. Basis of Design: Benjamin Moore Ultra Spec 500.

D. Interior, Latex, High-Performance Architectural Coating, Satin: High-performance architectural latex coating providing a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.

1. Gloss and Sheen Level: Manufacturer's standard low-sheen finish.
2. Basis of Design: Benjamin Moore Ultra Spec 500.

E. Interior, Water-Based Epoxy, High-Performance Maintenance Coating, Semigloss: High-performance two-part epoxy coating system providing a surface impervious to moisture; easily cleaned and sanitized.

1. Gloss Level: Manufacturer's standard semigloss finish.
2. Basis of Design: Rust-Oleum. Sierra Performance S60

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

B. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

C. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

3.3 INSTALLATION

A. Apply paints according to manufacturer's written instructions.

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

C. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:
    a. Uninsulated metal piping.
    b. Uninsulated plastic piping.
    c. Pipe hangers and supports.
    d. Metal conduit.
    e. Plastic conduit.
    f. Tanks that do not have factory-applied final finishes.
    g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 CLEANING AND PROTECTION

A. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

B. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Water-based rust-inhibitive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, institutional low odor/VOC, semigloss.

2. High-Performance Architectural Latex System:

    a. Prime Coat: Alkyd anticorrosive primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Topcoat: Interior, latex, high-performance architectural coating, semigloss.

B. Galvanized-Metal Substrates:

1. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Water-based galvanized primer.
    b. Intermediate Coat: Matching topcoat.
    c. Topcoat: Interior, latex, institutional low odor/VOC, semigloss.

2. High-Performance Architectural Latex System:

a. Prime Coat: Water-based galvanized primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, high-performance architectural coating, semigloss.

3. Water-Based Light-Industrial Coating System:

a. Prime Coat: Cementitious galvanized primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based, light-industrial coating, semigloss.

C. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Interior, institutional low-odor/VOC primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, institutional low odor/VOC, satin.

2. High-Performance Architectural Latex System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, high-performance architectural coating, satin.

3. High-Performance Water-Based Epoxy System:

a. Prime Coat: Interior latex primer sealer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, latex, high-performance architectural coating, satin.

END OF SECTION

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SECTION 09 96 00 - PROTECTIVE COATING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means minimum dry film thickness, without any negative tolerance.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

2. Stainless steel

3. Machined surfaces

4. Grease fittings

5. Glass

6. Equipment nameplates

7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

8. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Submittals shall include the following information and be submitted at least 30 Days prior to commencing protective coating WORK:

1. Materials List: Eight copies of a coating materials list showing the manufacturer and the product number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submitting samples.

2. Manufacturer's Information: For each coating system to be used, the following data:

   a. Manufacturer's data sheet for each product proposed, including statements on the suitability of the material for the intended use.

   b. Technical and performance information that demonstrates compliance with the system performance and material requirements.

   c. Paint manufacturer's instructions and recommendations on surface preparation and application.

   d. Colors available for each product (where applicable).

   e. Compatibility of shop and field applied coatings (where applicable).

   f. Material Safety Data Sheet for each product proposed.

C. Samples

1. Samples of paint, finishes, and other coating materials shall be submitted on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the ENGINEER from the manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the ENGINEER. The color formula shall be shown on the back of each color sample.

3. One 5 pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Suitability: The CONTRACTOR shall use suitable coating materials as recommended by the manufacturer. Materials shall comply with Volatile Organic Compound (VOC) limits applicable at the Site.

B. Material Sources: Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and the CONTRACTOR shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. Compatibility: In any coating system only compatible materials from a single manufacturer shall be used in the WORK. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Containers: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. Colors: Colors and shades of colors of coatings shall be as indicated or selected by the ENGINEER. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the ENGINEER.

F. Substitute or "Or-Equal" Products

1. To establish equality under Section 01 25 00 – Subsitution Procedures, the CONTRACTOR shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better in the following properties:

    a. Minimum and maximum recoat times

    b. Minimum and maximum cure time for immersion

    c. Abrasion resistance per ASTM D4060 using CS17 Wheel

    d. Maximum and minimum dry film thickness per coat

    e. Compatibility with other coatings

    f. Suitability for the intended service

    g. Resistance to chemical attack

    h. Temperature limitations during application and in service

    i. Type and quality of recommended undercoats and topcoats

    j. Ease of application

    k. Ease of repairing damaged areas

    l. Stability of colors

2. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. When requested, the CONTRACTOR shall provide the ENGINEER with the names of not less than 10 successful applications of the proposed manufacturer's products that comply with these requirements.

3. If a proposed substitution requires changes in the WORK, the CONTRACTOR shall bear such costs involved as part of the WORK.

2.2 INDUSTRIAL COATING SYSTEMS

A. System 1 - Alkyd Enamel

1. Materials

Primer	Manufacturer's recommendation
Finish Coat	1 component alkyd enamel
Type	high quality alkyd, medium long enamel
Demonstrated suitable for	ferrous and nonferrous surfaces in industrial exposure, producing high gloss surface that is resistant to mild corrosion and chemical fumes, has good color and gloss retention, good weathering, and sunlight resistance
VOC Content, max	420 grams per liter

2. Application and manufacturers

Prime Coat (DFT = 2 to 4 mils)	Finish Coat (DFT = 2 to 4 mils)	Total System DFT
PPG Amercoat 5105	**Amercoat 5450**	4 to 8 mils
Tnemec Series L69	**Tnemec Series 2H**	
Devoe Devprime 1401	**Devoe Devlac 1431**	
Carboline Carbocoat 150	**Carbocoat 45**	
Sherwin Williams Kem Bond HS	**S-W Industrial Enamel HS**	

2.3 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. System 100 - Amine Cured Epoxy

1. Material

Type	high build, amine cure epoxy
VOC content, g/L max	220
Demonstrated suitable for	steel, long term immersion in water and wastewater, resistant to corrosion, chemical fumes, good color retention
Certification	NSF 61 if in contact with potable water

2. Application and manufacturers

Products (3 coats or more)	Total System DFT
PPG- Amercoat 133	15 to 17 mils For non-submerged valves and other equipment, DFT = 10 to 12 mils
Carboline Carboguard 891HS	
International Bar-Rust 233H	
Tnemec Epoxoline Series L69	
Sherwin Williams Macropoxy 646 PW	

B. System 106 - Fusion Bonded Epoxy

1. Material

Type	100 percent solids fusion bond epoxy
Demonstrated suitable for	fluidized bed or electrostatic spray application, recommended for pumps, valves, pipe appurtenances, tanks, pipe hangers, flow meters, and hydrants
Certification requirement	NSF 61

2. Application in accordance with AWWA C213 and the following:

Product	Surface and DFT
3M Scotchkote 134 or 206N	Valves 12-mils
	All others 16-mils

2.4 SPECIAL COATING SYSTEMS

A. **System 205 - Polyethylene Encasement:** Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

B. System 208 - Aluminum Metal Isolation

1. Material

Type	high build polyamide epoxy with chemical and abrasion resistance
Demonstrated suitable for	concrete and aluminum substrates, to isolate aluminum from contact with concrete and the resulting chemical degradation

VOC content, max	250

2. Application and manufacturers

Coating (DFT = 16 - 20 mils)
PPG- Sigma, Novoguard 840
Sherwin Williams Macropoxy 646
Tnemec Epoxoline Series L69
Carboline 890
Devoe Bar-Rust 231

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. The CONTRACTOR shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems.

3.2 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating WORK.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the WORK shall be cleaned, repaired, and refinished to original condition.

3.3 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Manufacturer's Recommendations**:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.4 PREPARATION FOR COATING

A. General: Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The CONTRACTOR shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Protection of Surfaces Not to be Coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent WORK during blasting operations. Spraying shall be conducted under carefully controlled conditions. The CONTRACTOR shall be fully responsible for and shall promptly repair any and all damage to adjacent WORK or adjoining property occurring from blasting or coating operations.

E. Protection of Painted Surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces.

3.5 ENVIRONMENTAL REQUIREMENTS

A. No coating work shall be performed under the following conditions:

1. Surface or ambient temperatures exceed the manufacturer's recommended maximum or minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid conditions, where the relative humidity is above the manufacturer's maximum allowable.

4. Substrate and ambient temperatures are less than 5°F above the dew point and are decreasing. Dew point shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.

5. Ambient temperature that is expected to drop below 50°F or less than 5°F above the dew point within 8 hours after application of coating.

3.6 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC SP 1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC SP 2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC SP 3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC SP 5/NACE 1): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC SP 6/NACE 3): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC SP 7/NACE 4): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC SP 10/NACE 2): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. Power Tool Cleaning to Bare Metal (SSPC 11) When viewed without magnification, the surface shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted. The surface profile shall not be less than 1 mil (25 microns).

9. Surface Preparation of Concrete (SSPC-SP 13/NACE 6): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.7 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. The Shop Painting Facility shall use a minimum blast material mixture of 75% grit and 25% shot material to achieve the proper surface profile.

C. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP 7/NACE 4. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

D. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP 1.

E. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed and the surface prepared by SSPC SP 2 hand tool cleaning, and SSPC SP 3 power tool cleaning.

F. The Contractor shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter ($\mu g/cm^2$). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

G. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate's surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

H. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions.Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

I. The CONTRACTOR shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

J. Compressed air for air blast cleaning shall be supplied at adequate pressure from well-maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

K. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

L. Enclosed areas and other areas where dust settling is a problem shall be vacuum-cleaned and wiped with a tack cloth.

M. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

N. If the required abrasive blast cleaning will damage adjacent WORK, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP 2 or SSPC SP 3 may be used.

O. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP 1 before the abrasive blast cleaning has been started.

P. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

3.8 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP 1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by brush off blast cleaning per SSPC SP 7/NACE 4.

B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP 2 and power tool cleaned per SSPC SP 3.

C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.

D. The surfaces of galvanized steel exposed to chemical splashing or within a wastewater head space shall be abraded per SSPC SP 11 or SP 7 prior to coating.

3.9 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. General: Grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. Abrasive Blast Cleaning: The CONTRACTOR shall provide the degree of cleaning indicated in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC SP 6/NACE 3. Areas of tightly adhering coatings shall be cleaned to SSPC SP 7/NACE 4, with the remaining thickness of existing coating not to exceed 3-mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings the CONTRACTOR shall apply intermediate coatings per the manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. Unknown Coatings: Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. Water Abrasive or Wet Abrasive Blast Cleaning: Where indicated or where Site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged or severe service coating systems unless indicated.

3.10 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires top coating within a specific period of time, the equipment shall be finish-coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP 1 and SP 2. Damaged shop coating shall be cleaned in accordance with SSPC SP 3, Power Tool Cleaning, and recoated with the primer specified.

D. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10% of the coating manufacturer's recommended profile. If the surface profile does not meet the manufacturer's recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.

E. The interior surfaces of steel water reservoirs, except for Paragraph A surfaces, shall have surface preparation and coating WORK performed in the field.

F. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish-coated in the shop and touched up in the field with the identical material after installation. The CONTRACTOR shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

G. For certain small pieces of equipment the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

H. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being top coated or less time if recommended by the coating manufacturer.

I. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

J. The CONTRACTOR shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

3.11 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC PA1 - Paint Application Specification No. 1.

B. Cleaned surfaces and each coat shall be inspected prior to applying each succeeding coat. The CONTRACTOR shall schedule such inspection with the ENGINEER in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. CONTRACTOR shall use an independent stripe coat per SSPC PA Guide 11 for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.

F. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperatures exceeding the manufacturer's recommended maximum and minimum allowable.

2. Concrete surfaces will be in direct sunlight during application or within 3 hours after application.

3. Dust or smoke laden atmosphere.

4. Damp or humid weather.

5. Substrate or air temperature is less than 5 degrees F above the dew point.

6. Air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

7. Wind conditions are not calm.

I. Dew point shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.12 CURING OF COATINGS

A. The CONTRACTOR shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.13 IDENTIFICATION OF PIPING

A. Identification of piping shall be in accordance with Section 43 05 02 - Piping Identification Systems.

3.14 SHOP AND FIELD INSPECTION AND TESTING

A. General: The CONTRACTOR shall give the ENGINEER a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Such WORK shall be performed only in the presence of the ENGINEER, unless the ENGINEER has granted prior approval to perform such WORK in its absence.

C. Inspection by the ENGINEER, or the waiver of inspection of any particular portion of the WORK, shall not relieve the CONTRACTOR of its responsibility to perform the WORK in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the ENGINEER to facilitate inspection. Additional illumination shall be furnished on areas to be inspected.

E. Inspection Devices: The CONTRACTOR shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for the ENGINEER's use while coating is being done, until final acceptance of such coatings. The CONTRACTOR shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the ENGINEER.

F. Holiday Testing: The CONTRACTOR shall test for continuity all coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then be retested.

1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as **Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20,** or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.

2. Coatings with thickness of 20-mils or less total DFT: **Tinker & Rasor Model M1** non-destructive type holiday detector, **K-D Bird Dog,** or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a non-sudsing type wetting agent, such as **Kodak Photo-Flo** or equal, shall be added to the water prior to wetting the detector sponge.

G. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC Paint Application Specification No. 2 using a magnetic type dry film thickness gauge such as **Mikrotest Model FM, Elcometer Model 111/1EZ,** or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

H. Surface Preparation: Confirm proper surface profile with Testex Press-O-Film replica tape in accordance with NACE RP0287-02.

3.15 Coating System Schedule, Ferrous Metal - Not Galvanized

	Item	Surface Prep.	System No.
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC SP 6/NACE 3	(1) alkyd enamel
FM-8	Where indicated, ferrous surfaces in water passages, submerged surfaces of all pumps which have discharge size of 4 inches or larger, and all submerged and exposed ductile iron pipe.	White metal blast cleaning SSPC SP 5/NACE 1	(100) amine cure epoxy
FM-9	Ferrous surfaces of sleeve couplings.	Solvent cleaning SSPC SP 1, followed by white metal blast cleaning SSPC-SP 10/NACE 2	(106) fusion bond epoxy
FM-11	Buried surfaces that are not indicated to be coated elsewhere.	Near white metal blast cleaning SSPC SP 10/NACE 2	(100) amine cure epoxy
FM-19	Buried pipe couplings, valves, and flanged joints (where piping is ductile or cast iron, not tape-coated), including factory-coated surfaces.	As specified by reference specification	(205) polyethylene encasement

3.16 COATING SYSTEM SCHEDULE, NON-FERROUS METAL, PLASTIC, FIBER GLASS

A. Where isolated non-ferrous parts are associated with equipment or piping, the CONTRACTOR shall use the coating system for the adjacent connected surfaces. Do not coat handrails, gratings, frames or hatches. Only primers recommended by the coating manufacturer shall be used.

	Item	Surface Prep.	System No.
NFS-3	Aluminum surfaces in contact with concrete, or with any other metal except galvanized ferrous metal.	Solvent cleaned SSPC	(208) aluminum metal isolation

END OF SECTION

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SECTION 09 96 12 – POLYETHELENE TAPE WRAPPING FOR PIPE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide a prefabricated, cold-applied, multilayer polyethylene tape coating system on pipe, complete and in place, in accordance with the Contract Documents.

B. Except as described in this Section, the coating system shall be in accordance with AWWA C214 for straight pipe sections and AWWA C209 for fittings, specials, and joints.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Contractor Submittals
09 96 00	Protective Coatings

B. Reference Codes

1) References herein to "SSPC Specifications" or "SSPC" shall mean the published standards of AMPP, The Association for Materials Protection and Performance. The most recent version of referenced codes shall apply.

AMPP Standards	
SSPC-SP1	Solvent Cleaning
SSPC-SP6	Commercial Blast Cleaning
AWWA Standards	
AWWA C200	Steel Water Pipe 6 inches and larger
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00– Contractor Submittals.

B. Coating Materials List: A list of the tape coating materials that indicates the manufacturer, product numbers, technical information, and thickness of the materials.

C. Samples: Samples of the materials for testing by the Engineer. Each sample shall be clearly identified for catalog number, size, color, and other information required for testing.

1.4 QUALITY ASSURANCE

A. General: Furnish the Engineer a minimum of 7 Days advance notice of the start of any shop coating and a minimum of 3 Days advance notice for field coating.

B. Unless the Engineer has granted prior approval, coating WORK shall be performed in the presence of the Engineer.

C. Inspection Devices: The Contractor shall furnish inspection devices that are calibrated and in good working condition for the detection of holidays and measurement of coating film thicknesses.

D. Inspection: The Contractor shall retain the services of trained technicians to test the coating system in the shop and field and prepare reports. As a minimum, the tests shall include holiday detection and coating film thickness.

E. Tape application to straight pipe sections shall be monitored using instrumentation devices that continuously measure and record the tape width neckdown and the tape temperature. Each tape application station shall be equipped with the instrumentation devices. The tape tensions and temperatures shall be controlled using the data obtained from the instrumentation devices.

F. Manufacturer Representative: The Contractor shall require the tape material manufacturer to furnish a qualified factory technical representative to visit the pipe coating shop for technical support at the beginning of the tape coating operation and as may be necessary to resolve shop or field problems.

G. Holiday Detection: Electrical testing of the coating for flaws shall be performed with holiday detection equipment and settings approved by the Engineer.

H. Immediately before a coated pipe is lowered into the trench, the Contractor shall visually inspect and holiday test the entire coated surface of the pipe, except those areas that will be holiday inspected in the trench.

PART 2 -- PRODUCTS

2.1 COATING SYSTEMS

A. Straight pipe sections shall be provided with a multi-layer polyethylene tape system as described below.

1) Liquid Adhesive layer.

2) Filler tape, extruded butyl rubber compound compatible with the primer and tape.

3) Weld stripping tape, if required (25 mils).

4) Inner layer, corrosion protection tape (20 mils).

5) Middle layer, mechanical protection tape (30 mils).

6) Outer layer, mechanical protection tape (30 mils) with ultraviolet light stabilizers.

7) Total system thickness shall be at least 80 mils (nominal).

8) Coating materials shall be supplied by a single manufacturer, whose products have a successful application and service history on pipe fabricated in accordance with AWWA C200.

9) The coating system materials shall be as manufactured by Berry Plastics Corrosion Protection Group (Polyken) or equal, as itemized below:

Liquid Adhesive	1019 or 1033A or 1039 or HM 1100
Filler tape	939
Weld stripping tape	933-25 black, 6-in minimum width
Inner layer tape	989-20 black, 12-in maximum width
Middle layer tape	955-30 gray, 12-in maximum width
Outer layer tape	956-30 white, 12-in maximum width

B. Fittings, specials, and field joints shall be provided a 3 layer polyethylene tape system as described below:

1) Liquid Adhesive layer

2) Filler tape, extruded butyl rubber compound compatible with the primer and tape.

3) Inner layer, corrosion protection tape (50 mils).

4) Outer layer, mechanical and ultraviolet light protection tape (30 mils).

5) Total system thickness shall be at least 80 mils.

6) The coating materials shall be supplied by the same manufacturer as the materials for straight pipe.

7) The coating system materials shall be as manufactured by Berry Plastics Corrosion Protection Group (Polyken) or equal, as itemized below:

Liquid Adhesive	1027
Filler tape	939
Inner layer tape	930-50 black or 932-50
Outer layer tape	955-30 white or 905-30 white

8) The inner and outer layer tapes are to be applied with a minimum 1-in overlap. Other configurations, such as 930-35 can be applied in a “half lapped” configuration to achieve the overall system required thickness.

C. Storage of Materials: Materials shall be stored within the temperature ranges indicated for application, using heated storage areas if necessary. Tape shall be stored at a minimum temperature of 70 deg F. Not more than 85 deg F on the 989-20 and not more than 110 deg F on the 955 and the 956 middle and outer layer .The liquid Adhesive 1027 1033A or 1039 should not be heated higher than 70 deg F.

PART 3 -- EXECUTION

3.1 TAPE APPLICATION

A. Tape coating materials shall be applied in accordance with this Section, the product application instructions of the tape manufacturer, and the field technical support instructions from the manufacturer.

3.2 WELD SURFACE PREPARATION

A. To provide for an effective, long term bond between the tape coating system and the substrate, the following pipe weld surface preparation shall be provided.

1) Weld surfaces with a reinforcement greater than 1/32-in and all longitudinal and coil splice welds shall be ground to provide a smooth surface with a reinforcement not exceeding 1/32-in. The resulting weld surface shall have a cross-section shape that is free of discontinuities, abrupt changes in curvature, with no ridges or valleys that may promote bridging or disbondment of the tape from the substrate.

2) Weld Stripping Tape: Weld stripping tape, 6-in wide, shall be used if any of the following conditions are present.

a. If the Contractor elects to use stripping tape in lieu of grinding or part of the grinding required above. In such a case, the weld reinforcement shall not exceed 3/32-in, and the weld surface shall have a cross-section shape that is free of discontinuities, abrupt changes in curvature, with no ridges or valleys that may promote bridging or disbondment of the tape from the substrate.

b. If the initial pipe sections taped have indications that the inner tape layer is not bonding completely to the pipe at the welds.

c. If the tape bond to the welds or adjacent surfaces is less than the tape bond to the pipe surface away from the welds.

3) Welds that have any of the following require no additional preparation:

a. A reinforcement less than 1/32-in.

b. A cross-section slope that is free of discontinuities and abrupt changes in curvature.

c. No ridges or valleys that may promote bridging or disbondment of the tape from the substrate.

4) The tape shall be applied with the center of the tape at the weld.

3.3 PIPE SURFACE PREPARATION

A. Surfaces to be coated shall be detergent cleaned in accordance with SSPC-SP1 prior to abrasive blasting.

B. Burrs, sharp edges, and weld splatter shall be removed prior to abrasive blasting.

C. Immediately before application of the Liquid Adhesive, abrasive blasting shall be performed using sand, metallurgical slag, or a combination of steel grit and shot to produce a surface in conformance with SSPC-SP6. Steel grit shall comprise at least 60 percent of the working mix of abrasive if a centrifugal wheel abrasive blaster is used. The prepared surface profile shall be a minimum of 1.5 mils and no greater than 3.0 mils.

3.4 PIPE END PREPARATION

A. Coating cut-backs at the pipe ends shall be 6-in, with the cuts parallel to the pipe ends. Exposed substrate surfaces shall be protected with a storage primer applied immediately after taping and before flash rusting of the surface.

B. Spiral or longitudinal pipe welds within 2 ft of the pipe ends shall be ground flush prior to abrasive blast cleaning.

C. Pipe ends that will be connected with sleeve-type couplings shall be epoxy coated for immersion service in accordance with Section 09 96 00 – Protective Coatings. The cut-backs shall be greater than 6-in at couplings to provide clearance between the coupling and tape.

3.5 APPLICATION OF TAPE

A. Pipe external surface temperature shall be maintained within a range of 45 deg F to 100 deg F during application of the tape system.

B. Inner layer tapes shall be maintained at a minimum temperature of 70 deg F during application. Middle and outer layer tapes shall be maintained in a temperature range of 90 deg F to 110 deg F during application.

C. Tape application tension shall be maintained at a value that produces a tape width reduction of 1.0 to 2.0 percent of the tape width during application, as recommended by the tape manufacturer. This width reduction shall be maintained simultaneously with the minimum tape temperature.

D. At the point of tape application, all tape, including weld stripping tape, shall be pressed onto the pipe with a pressure roller that maintains a constant pressure. Enough pressure shall be used to fully bond the tape at welds.

E. Filler tape shall be used at lap joints, weld step-downs, and other discontinuities.

F. The tape application equipment and materials shall result in a fully bonded tape coating system, without blisters, voids, wrinkles or any areas that have a lack of bond to the pipe.

G. Succeeding layers of tape shall be applied so that the minimum overlap separation shall be not less than 25 percent of the roll width.

H. Before tape application, the liquid adhesive shall be dried sufficiently so that the liquid adhesive is in a dry condition.

I. Liquid Adhesive shall be applied while it is in a temperature range of 50 to 70 deg F, using airless spray equipment and a drum agitator. The liquid adhesive application shall be of uniform thickness on pipe surfaces.

3.6 REPAIR PATCHES

A. Repair patches shall be applied by wrapping tape completely around the pipe, using the tape system for joints.

3.7 STORAGE AND SHIPMENT

A. Pipe shall be square-stacked on padded supports or racks. Lifting equipment shall be padded and wide fabric slings shall be used. To the extent possible, the coated pipe shall be handled from the cut-back ends.

B. Tie down devices shall be padded where in contact with the pipe.

3.8 TAPE APPLICATION TO FITTINGS, SPECIALS, AND PIPE JOINTS

A. Filler tape shall be used to fill voids on fittings, specials, welds, and pipe joints.

B. Bell and spigot joints, lap joints, and other locations where voids will otherwise exist shall be provided specially shaped, filler tape applied after the liquid adhesive has been applied.

C. Field pipe joints shall be prepared as required by the paragraph above entitled "Pipe Surface Preparation," except that shop blasted surfaces that have been coated with a storage primer may be power tool cleaned instead of abrasive blast cleaned. The power tool cleaning shall be done in accordance with SSPC-SP2. Pipe ends not effectively protected with a storage primer shall be abrasive blasted to SSPC-SP6.

END OF SECTION

SECTION 10 14 23 - PANEL SIGNAGE

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel signs.

1.2 ACTION SUBMITTALS

A. Product Data: For panel signs.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: For exterior signs, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

B. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.2 PANEL SIGNS

A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Signage plaque requirements: per drawings, sheet 5A-19.

2. Mounting: Manufacturer's standard method for substrates indicated.

3. Surface Finish and Applied Graphics:
   a. Integral Acrylic Sheet Color: As selected by Architect from full range of industry colors.
   b. Painted Finish and Graphics: Manufacturer's standard, factory-applied exterior-grade sign paint in color as selected by Architect from manufacturer's full range.

2.3 PANEL-SIGN MATERIALS

A. Polycarbonate Sheet: Coated, mar-resistant, UV-stabilized polycarbonate, with coating on both sides.

B. Vinyl Film (Confirm with client if logo is required at main entrance): UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images for exterior applications.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:

1. Use concealed fasteners and anchors unless indicated to be exposed.
2. For exterior exposure, furnish stainless steel or hot-dip galvanized devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.

B. Adhesive: As recommended by sign manufacturer.

C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

B. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.

C. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

D. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color color unless otherwise indicated.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Install signs so they do not protrude or obstruct according to the accessibility standard.
3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

C. Remove temporary protective coverings and strippable films as signs are installed.

END OF SECTION

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SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Public-use washroom accessories.
2. Public-use shower room accessories.
3. Underlavatory guards.
4. Custodial accessories.

1.2 ACTION SUBMITTALS

A. Product data.

B. Delegated Design Submittals: For grab bars and shower seats.

1. Include structural design calculations indicating compliance with specified structural-performance requirements.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Structural Performance: Design accessories and fasteners to comply with the following requirements:

1. Grab Bars: Installed units are able to resist 250 lbf (1112 N) concentrated load applied in any direction and at any point.
2. Shower Seats: Installed units are able to resist 360 lbf (1601 N) concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Toilet Tissue (Roll) Dispenser:
   1. Basis of Design: Bobrick B-2840
   2. Description: Double-roll dispenser with shelf.
   3. Mounting: Surface mounted.
   4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Waste Receptacle:
   1. Basis of Design: Bobrick B-35649
   2. Mounting: Open top, surface mounted per drawings.
   3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

C. Combination Towel (Roll) Dispenser/Waste Receptacle:
   1. Basis of Design: B-3942 w/3974-350
   2. Description: Combination unit for auto-sensor activated dispensing roll towel, with removable waste receptacle.
   3. Mounting: Semi-recessed.
   4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
   5. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.

D. Automatic Soap Dispenser:
   1. Basis of Design: Bobrick B-2013
   2. Description: Automatic dispenser with infrared sensor to detect presence of hands; [**battery powered**]; designed for dispensing soap in lather form.
   3. Mounting: Surface mounted.
   4. Materials: Stainless Steel.
   5. Refill Indicator: LED indicator.
   6. Low-Battery Indicator: LED indicator.

E. Grab Bar:
   1. Mounting: Flanges with concealed fasteners.
   2. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
      a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.
   3. OD: 1-1/4 inches (32 mm).
   4. Configuration and Length: As indicated on Drawings.

F. Sanitary-Napkin Disposal Unit:
   1. Basis of Design: Bobrick B-270.
   2. Mounting: Surface mounted.
   3. Door or Cover: Self-closing, disposal-opening cover.
   4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

G. Sanitary-Napkin Disposal Unit:
   1. Basis of Design: Bobrick B-2706C.
   2. Mounting: Surface mounted.
   3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

H. Seat-Cover Dispenser:
   1. Basis of Design: Bobrick B-4221.
   2. Mounting: Surface mounted.

3. Exposed Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

I. Mirror Units:
1. Basis of Design: Bobrick B290 – 2430 and 2472
2. Frame: Stainless steel angle, 0.05 inch (1.3 mm) thick.
a. Corners: Welded and ground smooth.

J. Robe Hook:
1. Basis of Design: Bobrick B-76717
2. Description: Single prong unit.
3. Mounting: Concealed.
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

K. Shower Curtain Rod:
1. Description: 1-inch- (25.4-mm-) OD, straight rod.
2. Configuration: As indicated on Drawings.
3. Mounting Flanges: Concealed fasteners in material and finish matching rod.
4. Rod Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

L. Shower Curtain:
1. Size: Minimum 6 inches (152 mm) wider than opening by 72 inches (1829 mm) high.
2. Material: Nylon-reinforced vinyl, minimum 9 oz. (255 g) or 0.008-inch- (0.2-mm-) thick vinyl, with integral antibacterial and flame-retardant agents.
3. Color: White.
4. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
5. Shower Curtain Hooks: Chrome-plated or stainless steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

M. Folding Shower Seat:
1. Basis of Design: Bobrick B-5181
2. Configuration: L-shaped seat, designed for wheelchair access.
3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction in color as selected by Architect.
4. Mounting Mechanism: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.3 UNDERLAVATORY GUARDS

A. Underlavatory Guard:
1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

2.4 CUSTODIAL ACCESSORIES

A. Custodial Mop and Broom Holder:
1. Basis of Design: Bobrick B224

2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
3. Length: 36 inches (914 mm).
4. Hooks: Three.
5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
   a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
   b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

2.5 FABRICATION

A. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
   1. Remove temporary labels and protective coatings.

B. Grab Bars: Install to comply with specified structural-performance requirements.
C. Shower Seats: Install to comply with specified structural-performance requirements.

END OF SECTION

SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.
   1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 5-lb (2.3-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container; with pressure-indicating gage.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with red baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter fire extinguisher sign, triangle projection mount, mounted above fire extinguisher so as to be visible from multiple directions and not blocked by permanent partitions, casework, and/or equipment.

a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated. Provide blocking as needed.

1. Mounting Height: Top of fire extinguisher to be at 42 inches (1067 mm) above finished floor.

END OF SECTION

SECTION 10 51 13 - METAL LOCKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal Lockers.
2. Locker benches (OFOI).

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For metal lockers.

1. Include plans, elevations, sections, and attachment details.
2. Include locker identification system and numbering sequence.

C. Samples: For each color specified.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.4 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Warranty Period for Welded Metal Lockers: Lifetime.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers and locker benches indicated to be accessible, comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 SINGLE TIER WELDED LOCKERS

A. Manufacturers: Subject to compliance with requirements, manufacturers whose products may be incorporated into the work include but are not limited to the following:

1. List Industries Inc.
2. Lyon LLC
3. Penco Products

B. Perforated Doors: One piece; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet with manufacturer's standard diamond perforations; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches (381 mm) wide; welded to inner face of doors.

C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Intermediate Dividers: 0.060-inch nominal thickness, with single bend at sides.
2. Backs and Sides: 0.048-inch nominal thickness, with full-height, double-flanged connections.
3. Shelves: 0.060-inch nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 0.060-inch nominal-thickness steel sheet or 0.097-inch (2.45-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Hinges: Manufacturer's standard, steel, continuous or knuckle type.

F. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks, built-in key locks, or padlocks; positive automatic latching and prelocking.

a. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.105-inch nominal-thickness steel sheet; welded or riveted to full-height door strikes; with resilient silencer on each latch hook.
b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism.

G. Hooks: Manufacturer's standard ball-pointed hooks, aluminum or steel; zinc plated.

H. Coat Rods: Manufacturer's standard.

I. Legs: [6 inches (152 mm)] <Insert dimension> high; formed by extending vertical frame members, or fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to bottom of locker.

1. Provide closed front and end bases.

J. Continuous Zee Base: Fabricated from manufacturer's standard thickness, but not less than 0.060-inch (1.52-mm) nominal-thickness steel sheet.

1. Height: 4 inches (102 mm).

K. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.

L. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.

M. Finished End Panels: Fabricated from 0.024-inch (0.61-mm) nominal-thickness steel sheet.

N. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
2. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B; with A60 (ZF180) zinc-iron, alloy (galvannealed) coating designation.

O. Finish: Baked enamel or powder coat.

1. Color: As selected by Architect from manufacturer's full range.

2.3 LOCKER BENCHES (OFOI)

A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).

B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.

1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick) except provide 20- to 24-inch- (508- to 610-mm-) wide tops where accessible benches are indicated].
2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.

C. Fixed-Bench Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors.

1. Color: As selected by Client from manufacturer's full range.

D. Materials:

1. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 304.
2. Steel Tube: ASTM A500/A500M, cold rolled.

2.4 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.

D. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.

E. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.

F. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

G. Finished End Panels: Fabricated to conceal unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.

H. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top and bottom of lockers.

B. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.

C. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.

2. Attach filler panels with concealed fasteners.
3. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.

D. Fixed Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart.

END OF SECTION

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SECTION 11 30 13 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cooking appliances.
2. Kitchen exhaust ventilation.
3. Refrigeration appliances.
4. Cleaning appliances.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 COOKING APPLIANCES

A. Electric Range: Freestanding range with one oven(s) and complying with AHAM ER-1.
1. Electric Burner Elements: Four radiant or induction-type burners.
2. Anti-Tip Device: Manufacturer's standard.
3. Material: Stainless steel with ceramic-glass cooktop.

B. Microwave Oven:
1. Mounting: As indicated on Drawings.
2. Capacity: 2.0 cu. ft. (0.06 cu. m).
3. Microwave Power Rating: 1000 W.
4. Material: Stainless steel.

2.3 KITCHEN EXHAUST VENTILATION

A. Overhead Exhaust Hood KH-1

1. Nutone Mantra 30" 375 cfm 1.5 Sones: AVSF130ww
2. Type: Wall-mounted, exhaust-hood system.
3. Exhaust Fan: Variable-speed fan built into hood and with 375 cfm capacity.

    a. Venting: As indicated on Drawings.

4. Finish: Stainless steel.

2.4 REFRIGERATION APPLIANCES

A. Refrigerator/Freezer: Two-door refrigerator/freezer with freezer on bottom and complying with AHAM HRF-1.

1. Type: Freestanding.
2. Storage Capacity:

    a. Refrigeration Compartment Volume: 15.6 cu. ft. (0.44 cu. m).
    b. Freezer Volume: 5.13 cu. ft. (0.15 cu. m).

3. General Features:

    a. Dispenser in door for ice and cold water.
    b. Interior light in refrigeration compartment.
    c. Automatic defrost.
    d. Interior light in freezer compartment.
    e. Automatic icemaker and storage bin.

4. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
5. Front Panel(s): Stainless steel.

2.5 CLEANING APPLIANCES

A. Dishwasher: Complying with AHAM DW-1.
1. Type: Built-in undercounter.
2. Energy Star: Provide appliances that qualify for the EPA/DOE Energy Star product-labeling program.
3. Front Panel: Stainless steel.

B. Clothes Washer:

1. Basis of Design: Speed Queen LFNE5BSP115TW01
2. Type: Commercial free-standing, front-loading electric unit.
3. Capacity: 3.4 cu. ft.
4. Features:

    a. Electronic front controls.

5. Appliance Finish: Enamel.
6. Front-Panel Finish: Porcelain enamel.

C. Clothes Dryer:

1. Basis of Design: Speed Queen LDEE5BGS173TW01
2. Type: Commercial free-standing, frontloading, electric unit.
3. Capacity: 7.0 cu. ft. (0.20 cu. m).
4. Features:

a. Electronic front controls.
b. Reversible door.
c. Galvanized steel cylinder.
d. Extra-large capacity.
e. Door opening of 2.06 sq. ft.

5. Appliance Finish: Enamel.
6. Front-Panel Finish: Porcelain enamel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.

B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

C. Range Anti-Tip Device: Install at each range according to manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

END OF SECTION

SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manually operated roller shades with single rollers and accessories.

1.2 ACTION SUBMITTALS

A. Product Data and Warranty: For each type of product.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.

C. Samples: For each exposed product and for each color and texture specified.

1.3 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

A. Manufacturers: Subject to compliance with requirements, provide Hunter Douglas RB500 or a comparable product.

B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.

1. Chain-Retainer Type: Chain tensioner, sill mounted.

C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.

1. Roller Drive-End Location: Right side of interior face of shade.
2. Direction of Shadeband Roll: Regular, from back (exterior face) of roller.

D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.

E. Shadebands:

1. Shadeband Material: Light-filtering fabric.
2. Shadeband Bottom (Hem) Bar: fabric wrapped extruded aluminum to match shadeband.

F. Installation Accessories:

1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
   a. Intermediate fascia clips: at adjacent rollers and fascia, add clip/cover to conceal gap between fascia ends.
   b. Finish: Clear Anodized Aluminum.

2.2 SHADEBAND MATERIALS

A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.

1. Source: Hunter Douglas, GreenScreen Shading Fabric.
2. Type: Woven polyester.
3. Roll Width: See drawings.
4. Orientation on Shadeband: Non-Railroad, Up the bolt.
5. Openness Factor: 3 percent.
6. Color: Charcoal/Bronze.

2.3 ROLLER SHADE FABRICATION

A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1

B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows:
1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.

C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible.

PART 3 - EXECUTION

3.1 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.

D. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION

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SECTION 12 48 13 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roll-up rail mats.
2. Recessed frames.

1.2 COORDINATION

A. Coordinate size and location of recesses in concrete to receive floor mats and frames.

1.3 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 “Submittals” and below.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.

C. Shop Drawings:

1. Items penetrating floor mats and frames, including door control devices.
2. Divisions between mat sections.
3. Perimeter floor frames.

D. Samples: For the following products, in manufacturer's standard sizes:

1. Floor Mat: Assembled sections of floor mat.
2. Tread Rail: Sample of each type and color.
3. Frame Members: Sample of each type and color.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For floor mats and frames to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS AND FRAMES, GENERAL

A. Structural Performance: Provide roll-up rail mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:\

1. Uniform floor load of 300 lbf/sq. ft..
2. Wheel load of 350 lb per wheel.

B. Accessibility: Comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

2.2 ROLL-UP RAIL MATS

A. Basis of Design: Subject to compliance with requirements, provide *Pedimat M2***,** from *Construction Specialties Inc.,* or a comparable product by a qualified manufacturer which may include one of the following:

B. Roll-up, Hinged Mats: Extruded-aluminum tread rails 1 inches wide by 7/16 inch thick, sitting on continuous vinyl cushions.

1. Tread Inserts: Polypropylene blend of multifilament and monofilament, w/ integral color and UV blockers, fusion bonded to a rigid 2-ply backing. Carpet weight shall be 32oz./sq. yd.
2. Insert Color: See finish schedule on the Drawings.
3. Hinges and Rails: Clear-anodized aluminum, ASTM B221, Alloy 6063-T6
4. Mat Size: As indicated on the Drawings.

2.3 FRAMES

A. Recessed Level-Base Frames: Manufacturer's standard extrusion.

1. Extruded Aluminum: ASTM B221, Alloy 6063-T5

a. Clear-Anodized Finish.

2.4 CONCRETE FILL AND GROUT MATERIALS

A. Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregates no larger than one-third fill thickness.

2.5 FABRICATION

A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed

manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.

1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.

C. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and floor conditions for compliance with requirements for location, sizes, minimum recess depth, and other conditions affecting installation of floor mats and frames.

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

3.2 INSTALLATION

A. Install recessed mat frames and mats to comply with manufacturer's written instructions so that tops of mats will be flush with adjoining finished flooring. Set mats with tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.

3.3 PROTECTION

A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION

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SECTION 13 34 19 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural-steel framing.
2. Insulated metal roof panels.
3. Insulated metal wall panels.
4. Thermal insulation.
5. Personnel doors and frames.
6. Overhead doors.
7. Windows.
8. Accessories.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of metal building system component.

B. Shop Drawings: Indicate components by others. Include full building plan, elevations, sections, details and attachments to other work.

C. Samples: For units with factory-applied finishes.

D. Delegated Design Submittals: For metal building systems.

1. Include analysis data indicating compliance with performance requirements and design data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Letter of Design Certification: Signed and sealed by a qualified professional engineer. Include the following:

1. Name and location of Project.
2. Order number.
3. Name of manufacturer.
4. Name of Contractor.
5. Building dimensions including width, length, height, and roof slope.

6. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
7. Governing building code and year of edition.
8. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
9. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
10. Building-Use Category: Indicate category of building use and its effect on load importance factors.

C. Material test reports.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.

1. Accreditation: Manufacturer's facility accredited according to IAS AC472, "Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems."
2. Engineering Responsibility: Preparation of comprehensive engineering analysis and Shop Drawings by a professional engineer who is legally qualified to practice in jurisdiction where Project is located.

B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 GENERAL

A. Structural Requirements
1. Pre-engineered metal building(s), including structural framing, accessories, related assemblies, components, appurtenances, and attachment details shall

comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.
    a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria
2. The CONTRACTOR shall provide additional non-standard bracing, reinforcement, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.
3. Pre-engineered metal building(s) including related assemblies, components, and accessories shall be manufactured and installed to maintain the specified performance requirements, under the structural design criteria indicated, without defects, damage, or failure.

B. Thermal Movements: Pre-engineered metal building(s) and accessories shall be designed to provide for such expansion and contraction of component materials as will be caused by temperature changes without causing buckling, stresses or other cladding components, failure of joints, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other visual or technical detrimental effects.

C. MANUFACTURER and Product, or Equal
1. Subject to the requirements indicated, provide MANUFACTURER and product listed below, or equal as approved by the OWNER.
    a. **R&M Steel Company** – With additional options and custom features as specified herein.
    b. **Butler Manufacturing Company** – With additional options and custom features as specified herein.
    c. **Garco Building Systems** – With additional options and custom features as specified herein.
    d. **Nucor Building Systems** – With additional options and custom features as specified herein.
    e. **Star Building Systems** – With additional options and custom features as specified herein.
    f. **Varco-Pruden Buildings** – With additional options and custom features as specified herein.

D. Description
1. Pre-engineered metal building(s) shall be provided complete, and shall include the structural framing, connections, anchor bolts, framed openings for wall, roof and penetrations, and framed openings for doors, windows and louvers; metal roofing and scrim faced insulation with metal wall panel system, soffit panel system, gutters and downspouts, pipe flashing, gable trim, flashing, closures, fasteners, sealants, and all other component parts for a complete weathertight, exterior envelope. Building shall be fully insulated in walls and roof.
    a. Dimensions: The dimensions shall be as indicated on the Contract Documents. The minimum clear height to the underside of the roof members at their lowest point (eave height) shall be as indicated on the Contract Documents. The roof slope shall be a minimum of ½ inch per foot and meet code requirements.
    b. Structural System

1) The building's structural system shall be a clear span rigid frame system as determined by the MANUFACTURER and in coordination with the Contract Documents.
2) The building's structural system shall be selected such that it is compatible with the foundation system shown on the Contract Documents.

2.2 MATERIALS

A. Metals
1. Members fabricated from plate or bar stock: provide 42,000 psi minimum yield strength and comply with the requirements of ASTM A529, A1001, or A572.
2. Members fabricated by cold forming: ASTM A1008, Grade 50.
3. Galvanized steel sheet: ASTM A653 with G90 coating.
4. Bolts for structural framing: ASTM F3125 Grade A325 bolts.
5. Anchors into concrete: ASTM A307.
6. Hot rolled structural shapes: ASTM A36, A570, or A992.

2.3 DESIGN CRITERIA

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 1, to design metal building system.

B. Structural Performance Metal building systems to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."

1. Design Loads: ASCE-7 and Washington State Building Code
2. Deflection and Drift Limits:

a. Design metal building system assemblies to withstand serviceability design loads without exceeding deflections and drift limits recommended in AISC Steel Design Guide No. 3 "Serviceability Design Considerations for Steel Buildings."

C. Seismic Performance: Metal building system to withstand the effects of earthquake motions determined according to ASCE/SEI 7.

D. Collateral loads shall include dead and live loads resulting from HVAC, piping, and other items suspended from the roof. This loading shall be coordinated with the drawings of all disciplines and MANUFACTURER's shop drawings.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

F. Structural Performance for Metal Roof and Wall Panels: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.

G. Air Infiltration for Metal Roof Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft.

H. Air Infiltration for Metal Wall Panels: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft.

I. Water Penetration for Metal Roof Panels: No water penetration when tested according to ASTM E1646 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft.

J. Water Penetration for Metal Wall Panels: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).

K. Thermal Performance for Opaque Elements: Provide the minimum R-values indicated when tested according to ASTM C1363 or ASTM C518.

L. For design of structural panels, comply with the requirements of AISC.

M. For design of light gage steel members, comply with AISI for design requirements and allowable stresses.

N. Welded connections shall comply with AWS.

2.4 FOUNDATION AND FLOOR SLAB

A. The foundation and floor slab shall be reinforced concrete conforming to the requirements of the Code and shall be provided by the CONTRACTOR.

B. The pre-engineered metal building MANUFACTURER shall design the anchorages for the pre-engineered metal building and make any recommendations for base plate revision based on actual loading. The CONTRACTOR shall coordinate the anchorage and base plate details with the foundation and pre-engineered metal building engineer.

C. The CONTRACTOR shall coordinate the details of anchorages of the pre-engineered metal building to its foundation. The CONTRACTOR shall provide the anchor bolts and layout templates and allow for any foundation revisions necessary to adapt or support the pre-engineered metal building during construction as accepted by the ENGINEER.

2.5 STRUCTURAL-STEEL FRAMING

A. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings."

B. Bolted Connections: Comply with RCSC's "Specification for Structural Joints Using High-Strength Bolts."

C. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

D. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements. Primary framing includes transverse and lean-to frames; rafters and rake beams; sidewall, intermediate, end-wall, and corner columns; and wind bracing.

1. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.

E. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, pre-painted with coil coating:

F. Anchor Rods: Headed anchor rods as indicated in Anchor Rod Plan for attachment of metal building to foundation.

2.6 FOAMED-INSULATION-CORE METAL ROOF PANELS

A. Basis of Design Product: Subject to compliance with requirements, provide KingSeam Roof Panel by Kingspan Insulated Panels Ltd. or a comparable product.

B. Standing Seam, Foamed-Insulation-Core Metal Roof Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

1. Panel Face: 22 gauge, AZ50/Galvalume per ASTM A792, minimum grade 33.

a. Exterior Finish: Three-coat fluoropolymer.
b. Interior Finish: Manufacturer’s standard modified polyester finish, minimum 1.0 mil thickness.
c. Colors: As selected by Architect from manufacturer's full range.

2. Profile: Shallow mesa rib.
3. Texture: Smooth, non-embossed.
4. Panel Coverage: 40 inches.
5. Panel Thickness: 4 inches.
6. Insulating Core: Manufacturer’s standard urethane modified isocyanurate insulation complying with the following criteria:

a. Density Nominal: 2.0-2.5 pcf per ASTM C1622.
b. Shear Strength: 14 psi per ASTM C273.
c. Tensile Adhesion: 8.25 psi per ASTM C1623.
d. Compressive Strength: 14 psi per ASTM D1621.
e. Surface burning characteristics when tested in accordance with ASTM E84:

1) Flame Spread: less than 25
2) Smoke Developed: less than 450

7. Panel Thermal-Resistance Value (R-Value): R28.

2.7 FOAMED-INSULATION-CORE METAL WALL PANELS

A. Basis of Design Product: Subject to compliance with requirements, provide; QuadCore Optimo Panel by Kingspan Insulated Panels Ltd. or a comparable product.

1. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

a. Panel Face: 22 gauge, AZ50/Galvalume per ASTM A792, minimum grade 33.
1) Exterior Finish: Two-coat fluoropolymer.
2) Interior Finish: Manufacturer's standard modified polyester finish, minimum 1.0 mil thickness.
3) Colors: As selected by Architect from manufacturer's full range.
b. Profile: Flat.
c. Texture: Smooth.
d. Panel Coverage: 40 inches.
e. Reveal: 1 inch.
f. Panel Thickness: 3 inches.
g. Insulating Core: Manufacturer's standard isocyanurate insulation complying with the following criteria:
1) Density Nominal: 2.0-2.8 pcf per ASTM C1622.
2) Shear Strength: 22 psi per ASTM C273.
3) Tensile Adhesion: 24 psi per ASTM C1623.
4) Compressive Strength: 24 psi perASTM D1621.
5) Surface burning characteristics when tested in accordance with ASTM E84:
a) Flame Spread: less than 25
b) Smoke Developed: less than 450

B. Basis of Design Product: Subject to compliance with requirements, provide; QuadCore, KS Series Panel by Kingspan Insulated Panels Ltd. or a comparable product.

1. Concealed-Fastener, Foamed-Insulation-Core Metal Wall Panels: Formed with tongue-and-groove panel edges; designed for sequential installation by interlocking panel edges and mechanically attaching panels to supports using concealed clips or fasteners.

a. Panel Face: 22 gauge, AZ50/Galvalume per ASTM A792, minimum grade 33.
1) Exterior Finish: Two-coat fluoropolymer.
2) Interior Finish: Manufacturer's standard modified polyester finish, minimum 1.0 mil thickness.
3) Colors: As selected by Architect from manufacturer's full range.
b. Profile: Flat.
c. Reveal: 1/8 inch.

d. Texture: Smooth.
e. Panel Coverage: 42 inches.
f. Panel Thickness: 3 inches.
g. Insulating Core: Manufacturer's standard isocyanurate insulation complying with the following criteria:
    1) Density Nominal: 2.0-2.8 pcf per ASTM C1622.
    2) Shear Strength: 22 psi per ASTM C273.
    3) Tensile Adhesion: 24 psi per ASTM C1623.
    4) Compressive Strength: 24 psi perASTM D1621.
    5) Surface burning characteristics when tested in accordance with ASTM E84:
        a) Flame Spread: less than 25
        b) Smoke Developed: less than 450

C. Wall Panel Thermal-Resistance Value (R-Value): R24.

2.8 PERSONNEL DOORS AND FRAMES

A. Provide in accordance with Section 08 11 13 "Steel Doors and Frames".

2.9 OVERHEAD SECTIONAL DOORS

A. Provide in accordance with Section 08 36 13 "Sectional Doors".

2.10 WINDOWS

A. Provide in accordance with Section 08 51 13 "Aluminum Windows".

2.11 ACCESSORIES

A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.

1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

B. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including copings, fasciae, corner units, ridge closures, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.

C. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including copings, fasciae, mullions, sills, corner units, clips, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels unless otherwise indicated.

D. Flashing and Trim: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match adjacent metal panels.

E. Gutters: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match roof fascia and rake trim. Match profile of gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2438-mm-) long sections, sized according to SMACNA's "Architectural Sheet Metal Manual."

1. Gutter Supports: Fabricated from same material and finish as gutters.
2. Strainers: Bronze, copper, or aluminum wire ball type at outlets.

F. Downspouts: Zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet, 0.018-inch (0.46-mm) nominal uncoated steel thickness, prepainted with coil coating; finished to match metal wall panels. Fabricate in minimum 10-foot- (3-m-) long sections, complete with formed elbows and offsets.

1. Mounting Straps: Fabricated from same material and finish as gutters.

G. Pipe Flashing: Premolded, EPDM pipe collar with flexible aluminum ring bonded to base.

2.12 FABRICATION

A. General: Design components and field connections required for erection to permit easy assembly.

1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.
2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members to be free of cracks, tears, and ruptures.

B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.

C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.

D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll forming or break forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.

E. Metal Panels: Fabricate and finish metal panels at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.

1. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of metal panel.

2.13 SOURCE QUALITY CONTROL

A. Special Inspection: Owner will engage a qualified special inspector to perform source quality control inspections and to submit reports.

1. Accredited Manufacturers: Special inspections will not be required if fabrication is performed by an IAS AC472-accredited manufacturer approved by authorities having jurisdiction to perform such Work without special inspection.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ERECTION OF STRUCTURAL FRAMING

A. Erect metal building system according to manufacturer's written instructions and drawings.

B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.

C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.

D. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

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

E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set

with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.

1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt type and joint type specified.

    a. Joint Type: Snug tightened or pretensioned as required by manufacturer.

G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.

1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
2. Locate and space wall girts to suit openings such as doors and windows.
3. Provide supplemental framing at entire perimeter of openings, including doors, windows, ventilators, and other penetrations of roof and walls.

H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.

1. Tighten rod and cable bracing to avoid sag.
2. Locate interior end-bay bracing only where indicated.

I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.

J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.2 METAL PANEL INSTALLATION, GENERAL

A. General: Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cut metal panels as required for doors, windows, and other openings. Cut openings as small as possible, neatly to size required, and without damage to adjacent metal panel finishes.

    a. Field cutting of metal panels by torch is not permitted unless approved in writing by manufacturer.

2. Install metal panels perpendicular to structural supports unless otherwise indicated.
3. Flash and seal metal panels with weather closures at perimeter of openings and similar elements. Fasten with self-tapping screws.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Locate metal panel splices over structural supports with end laps in alignment.
6. Lap metal flashing over metal panels to allow moisture to run over and off the material.

B. Lap-Seam Metal Panels: Install screw fasteners using power tools with controlled torque adjusted to compress EPDM washers tightly without damage to washers, screw threads, or metal panels. Install screws in predrilled holes.

1. Arrange and nest side-lap joints so prevailing winds blow over, not into, lapped joints. Lap ribbed or fluted sheets one full rib corrugation. Apply metal panels and associated items for neat and weathertight enclosure. Avoid "panel creep" or application not true to line.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal panel assemblies. Provide types of gaskets, fillers, and sealants indicated; or, if not indicated, provide types recommended by metal panel manufacturer.

1. Seal metal panel end laps with double beads of tape or sealant the full width of panel. Seal side joints where recommended by metal panel manufacturer.

3.3 METAL ROOF PANEL INSTALLATION

A. General: Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.

1. Install ridge caps as metal roof panel work proceeds.
2. Flash and seal metal roof panels with weather closures at eaves and rakes. Fasten with self-tapping screws.

B. Lap-Seam Metal Roof Panels: Fasten metal roof panels to supports with exposed fasteners at each lapped joint, at location and spacing recommended by manufacturer.

1. Provide metal-backed sealing washers under heads of exposed fasteners bearing on weather side of metal roof panels.
2. Provide sealant tape at lapped joints of metal roof panels and between panels and protruding equipment, vents, and accessories.
3. Apply a continuous ribbon of sealant tape to weather-side surface of fastenings on end laps and on side laps of nesting-type metal panels, on side laps of ribbed or fluted metal panels, and elsewhere as needed to make metal panels weatherproof to driving rains.
4. At metal panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with butyl-rubber sealant and fastened together by interlocking clamping plates.

C. Metal Fascia Panels: Align bottom of metal panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws. Flash and seal metal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.4 METAL WALL PANEL INSTALLATION

A. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts, extending full height of building, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Unless otherwise indicated, begin metal panel installation at corners with center of rib lined up with line of framing.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. When two rows of metal panels are required, lap panels 4 inches (102 mm) minimum.
4. When building height requires two rows of metal panels at gable ends, align lap of gable panels over metal wall panels at eave height.
5. Rigidly fasten base end of metal wall panels and allow eave end free movement for thermal expansion and contraction. Predrill panels.
6. Flash and seal metal wall panels with weather closures at eaves and rakes, and at perimeter of all openings. Fasten with self-tapping screws.
7. Install screw fasteners in predrilled holes.
8. Install flashing and trim as metal wall panel work proceeds.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated on Drawings; if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-drilling or self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.

B. Metal Wall Panels: Install metal wall panels on exterior side of girts. Attach metal wall panels to supports with fasteners as recommended by manufacturer.

3.5 DOOR AND FRAME INSTALLATION

A. General: Install doors and frames plumb, rigid, properly aligned, and securely fastened in place according to manufacturers' written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for metal wall panels.

B. Personnel Doors and Frames: Install doors and frames according to NAAMM-HMMA 840.

C. Door Hardware:

1. Install surface-mounted items after finishes have been completed at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
4. Set thresholds for exterior doors in full bed of sealant complying with requirements for concealed mastics specified in Section 079200 "Joint Sealants."

3.6 WINDOW INSTALLATION

A. General: Install windows plumb, rigid, properly aligned, without warp or rack of frames or sash, and securely fasten in place according to manufacturer's written instructions. Coordinate installation with wall flashings and other components. Seal perimeter of each window frame with elastomeric sealant used for metal wall panels.

1. Separate dissimilar materials from sources of corrosion or electrolytic action at points of contact with other materials by complying with requirements specified in AAMA/WDMA/CSA 101/I.S.2/A440.

B. Set sill members in bed of sealant or with gaskets, for weathertight construction.

C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

D. Mount screens directly to frames with tapped screw clips.

3.7 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly, including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
2. Install components for a complete metal wall panel assembly, including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
3. Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with corrosion-resistant coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by manufacturer.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil-canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted-and-soldered or lapped-and-sealed joints. Attach gutters to eave with gutter hangers spaced as required for gutter size, but not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Tie downspouts to underground drainage system indicated.

E. Continuous Roof Ventilators: Set ventilators complete with necessary hardware, anchors, dampers, weather guards, rain caps, and equipment supports. Join sections with splice plates and end-cap skirt assemblies where required to achieve indicated length. Install preformed filler strips at base to seal ventilator to metal roof panels.

F. Roof Curbs: Install curbs at locations indicated on Drawings. Install flashing around bases where they meet metal roof panels.

G. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to panel as recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform field quality control special inspections and to submit reports.

B. Product will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

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SECTION 13 34 21 - PRE-ENGINEERED METAL CANOPIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide a pre-engineered metal canopy and appurtenant WORK, complete and in place, with operational components, in accordance with the Contract Documents. The canopy is intended to be installed above the effluent drum filter sump.

B. The CONTRACTOR shall furnish professional design and engineering services as required for pre-engineered metal canopie(s) and appurtenances as indicated herein.

1. Professional design and engineering services may be provided by the manufacturer or by an independent licensed structural engineer retained by the CONTRACTOR, either of which shall comply with the requirements indicated.

C. The CONTRACTOR shall coordinate color samples with other Sections through the submittal process.

1.2 REFERENCES

A. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

B. American Institute of Steel Construction (AISC)

AISC Steel Construction Manual, Thirteenth Edition

C. American Iron and Steel Institute (AISI)

AISI Specification for the Design of Cold Formed Steel Structural Members

AISI Design of Light Gage Steel Diaphragms

D. American Society for Testing and Materials (ASTM)

ASTM A 36	Specification for Carbon Structural Steel
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Ultimate Tensile Strength
ASTM A 325	Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Ultimate Tensile Strength
ASTM A 529	Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A 572	Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

ASTM A 653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 992	Steel for Structural Shapes For Use In Building Framing
ASTM A 1008	Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM A 1011	Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength

E. American Welding Society

AWS D1.1	Structural Welding Code-Steel

F. Metal Building Manufacturer's Association (MBMA)

Metal Building Systems Manual.

G. Architectural Aluminum Manufacturers Association (AAMA).

H. Building Code: Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as "the CODE."

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

1. Complete operation instructions for operable components.

2. Manufacturer's full-range color charts, indicating custom color availability for color selection by the OWNER.

3. Additional information for the canopy system, roof panels, accessories and components.

C. Warranty: Submit a copy of the warranty.

D. Certifications

1. Certification of compliance with the Structural Requirements of paragraph 2.1.A.

2. Certification of manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

4. Certification from the manufacturer stating that galvanizing has been completed in accordance with these specifications.

5. Certification of welder qualifications in accordance with the American Welding Society Code for Building Construction.

6. When requested by the ENGINEER, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Shop Drawings and Design Calculations: Complete Shop Drawings showing location and details of installation, and design calculations.

1. Shop Drawings and Design Calculations shall be prepared, signed, and stamped by a professional civil or structural engineer registered in the State of Washington.

2. Shop Drawings shall be drawn to sufficient scale, showing fully-dimensioned layout, including plans, sections, elevations and details of construction, connections to the foundation, joints, penetration details, preformed metal closures, flashing, gutters, and downspouts, fastenings, system caulking, sealants, gaskets, appurtenances, locations of framed openings, special project specific conditions, location of custom-cut panels, provisions for expansion and contraction, connections, accessories, and trim.

a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each pre-engineered metal canopy and shall include, as a minimum:

1) Erection drawings with written procedures to clearly explain proper installation of fasteners, trim, gaskets, and sealants. Erection drawings shall also include a notation requiring the installer to coordinate with other trades.

2) Transverse cross sections.

3) Roof plans showing sizes and locations of structural panels and connections.

4) Design and detail penetrations to be weathertight. Coordinate locations of penetrations.

5) Manufacturer's standard details may be used in addition to the shop drawings listed above provided that the portions that apply are clearly marked and those parts that do not apply are clearly marked.

6) Foundation and floor slab drawings.

a) Foundation anchor bolt plan with anchor bolts, shear lugs (if required) and base plate details. A diagram shall be included showing the

vertical and lateral loads applied on the foundation for each load combination.

b) Floor slab drawings shall show the location of all construction joints, blockouts and details of the interface between the foundation and floor slab.

3. Design Calculations

a. Design calculations shall include a complete stress and deflection analysis of all structural components and connections.

b. Design calculations shall include supporting information for the structural roof deck with ICC-ES/IAPMO approval substantiating the capacity of the deck to act as a roof diaphragm and provide lateral support for out-of-plane loading as necessary.

c. Design calculations shall substantiate a complete load path for the wind and seismic lateral force resisting system including design of drag, collector and bracing elements (including connections) required to transfer loading, including overstrength factors, to the foundation. The design calculations shall specifically address anchorage of the structural system to the foundation, including detailing of baseplates and anchor rods. Detailing shall consider edge distance and clearance requirements at slab edges, blockouts and curbs.

4. Specifications for the painting system including paint manufacturer's name, product trade name, and preparation for shop and field coats.

F. Deferred Approval: The shop drawings and design calculations shall be submitted to the Building Official(s) having jurisdiction for review and approval prior to construction. The CONTRACTOR shall provide all engineering support as necessary during the review process with all Building Official(s) having jurisdiction, including providing responses to review comments, attendance at meetings, and submitting all requested documentation.

G. Samples: The CONTRACTOR shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the ENGINEER. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the CONTRACTOR from compliance with the Contract Documents.

1. Metal Roof Panels

a. Assembled half panels, with representative panel support framing, showing seam, and appurtenances; one-foot long, in color and finish indicated.

b. Three-inches (76 mm) by 4-inch (102 mm) color samples showing substrate, finish, and color.

2. Gutter and downspout: One-foot (.30 m) long section of each in material, profile, finish, and color indicated.

3. Finish trim, closure pieces, and sealant, one-foot long (.30 m) each.

4. Samples of each type fastener required, identified as to use.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Pre-engineered metal canopies and components shall be provided by a single manufacturer.

B. Manufacturer Qualifications

1. Pre-engineered metal canopy manufacturer shall be a current member of the Metal Building Manufacturer's Association (MBMA).

2. Pre-engineered metal canopy manufacturer shall have a minimum of 20 years of Pre-engineered metal canopy manufacturing experience.

3. Pre-engineered metal canopy manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

4. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installer shall be trained, certified, and authorized by the manufacturer to install the manufacturer's product.

3. Installers without these qualifications will not be accepted.

1.5 SPECIAL WARRANTY PROVISIONS

A. For pre-engineered metal canopie(s) and appurtenances furnish manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Installation Warranty: At the time of Substantial Completion, the manufacturer shall warrant that the installation is not defective in and conforms to the manufacturer's erection drawings, except for reasonable variances not impairing the usefulness thereof.

C. Finish Warranty: The manufacturer shall warrant against spalling, fading, chalking, peeling, cracking, checking, chipping, or erosion to base metal of the exterior roof panel finish, for a period of 10 years from the date of Substantial Completion. The finish shall not change color more than eight NBS units for a period of 10 years from the date of Substantial Completion.

D. Weathertight Warranty: Manufacturer shall provide a weathertight warranty against water penetration of the pre-engineered metal canopy system, including panel joints and trim conditions for a period of 20 years from date of Substantial Completion.

E. In the event that the pre-engineered metal canopy fails to meet the warranty standards above, the manufacturer shall, at the manufacturer's sole cost (including labor and materials), replace or repair the pre-engineered metal canopy, as agreeable to the OWNER throughout the term of the warranty.

F. The CONTRACTOR shall furnish separate, but concurrently running, 5-year written warranty to cover installation and associated labor.

G. The term of the warranties shall begin on the date of Substantial Completion, unless otherwise indicated.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Structural Requirements

1. Pre-engineered metal canopie(s), including structural framing, accessories, related assemblies, components, appurtenances and attachment details shall comply with the CODE and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the CODE. Where a conflict occurs between the requirements of this Section and the CODE, the more stringent shall apply.

2. The CONTRACTOR shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

3. Pre-engineered metal canopie(s) including related assemblies, components, and accessories shall be manufactured and installed to maintain the specified performance requirements, under the structural design criteria indicated, without defects, damage, or failure.

B. Thermal Movements: Pre-engineered metal canopie(s) and accessories shall be designed to provide for such expansion and contraction of component materials as will be caused by temperature changes without causing buckling, stresses or other cladding components, failure of joints, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other visual or technical detrimental effects.

C. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. **R&M Steel Company** – With additional options and custom features as specified herein.
b. **Butler Manufacturing Company** – With additional options and custom features as specified herein.
c. **Garco Building Systems** – With additional options and custom features as specified herein.
d. **Nucor Building Systems** – With additional options and custom features as specified herein.

e. **Star Building Systems** – With additional options and custom features as specified herein.
f. **Varco-Pruden Buildings** – With additional options and custom features as specified herein.

a.

D. Description

1. Pre-engineered metal canopie(s) shall be provided complete, and shall include the structural framing, connections, anchor bolts, framed openings for roof penetrations, metal roofing, gutters and downspouts, pipe flashing, gable trim, flashing, closures, fasteners, sealants, and all other component parts for a complete weathertight, exterior envelope. Additional requirements include the method for attaching predator prevention cables and netting.

a. Dimensions: The dimensions shall be as indicated on the Contract Documents. The minimum clear height to the underside of the roof members at their lowest point (eave height) shall be as indicated on the Contract Documents. The roof slope shall be a minimum of ½ inch per foot and meet code requirements.

b. Structural System

1) The building's structural system shall be a clear span rigid frame system as determined by the manufacturer and in coordination with the Contract Documents.

2) The building's structural system shall be selected such that it is compatible with the foundation system shown on the Contract Documents.

2.2 MATERIALS

A. Metals

1. Members fabricated from plate or bar stock: provide 42,000-psi minimum yield strength and comply with the requirements of ASTM A529, A1011, or A572.

2. Members fabricated by cold forming: ASTM A 1008, Grade 50.

3. Galvanized Steel Sheet: ASTM A 653 with G90 coating.

4. Bolts for Structural Framing: ASTM A325.

5. Anchors into concrete: ASTM A307

6. Hot rolled structural shapes: ASTM A36, A570, or A992.

2.3 DESIGN CRITERIA

A. Design Loads

1. Roof live load, snow load, wind load, and seismic load shall be per the design criteria listed on the Structural General Notes Drawing GS-1

B. Design Requirements

1. Design roof panels and exterior covering materials for applicable loads and combinations of loads in accordance with the MBMA Metal Building Design Manual.

2. For design of light gage steel members, comply with AISI for design requirements and allowable stresses.

3. Welded connections shall comply with AWS.

4. Design framing to withstand stresses resulting from combinations of loads that produce the maximum allowable stresses in that member as prescribed in MBMA's Metal Building Design Manual.

2.4 FOUNDATION AND FLOOR SLAB

A. The foundation and floor slab shall be reinforced concrete conforming to the requirements of the CODE and shall be provided by the CONTRACTOR.

B. The pre-engineered metal canopy MANUFACTURER shall design the anchorages for the pre-engineered metal canopy and make any recommentaions for base plate revision based on actual loading. The CONTRACTOR shall coordinate the anchorage and base plate details wth the foundation and pre-engineered metal canopy engineer.

C. The pre-engineered metal canopy manufacturer shall design the base plates and their attachment to the pre-engineered metal canopy.

D. The CONTRACTOR shall coordinate the details of anchorages of the pre-engineered metal canopy to its foundation. The CONTRACTOR shall provide the anchor bolts and layout templates and allow for any foundation revisions necessary to adapt or support the pre-engineered metal canopy during construction as accepted by the ENGINEER.

2.5 STRUCTURAL FRAMING

A. Description

1. Design of the structural system for the pre-engineered metal canopy shall be clear span rigid frame with tapered columns, tapered roof beams, and gable roof.

2. Primary Framing

a. Rigid Frames

1) Frames shall consist of welded plate section columns and roof beams complete with necessary splice plates for bolted field assembly.

2) Welding shall be performed in accordance with the American Welding Society Code for Building Construction.

3) All base plates, cap plates, compression plates, and stiffener plates shall be factory-welded into place and have the connection holes shop fabricated.

4) All splice plates shall be shop fabricated complete with bolt connection holes.

5) Columns and roof beams shall be fabricated complete with holes in webs and flanges for the attachment of secondary structural members and bracing.

b. All bolts for field assembly of frame members shall be high strength bolts as indicated on erection drawings.

c. Endwall Structurals

1) Endwall frames shall consist of endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.

a) All splice plates and connection clips shall be shop fabricated complete with bolt connection holes.

b) Beams and posts shall be shop fabricated complete with holes for the attachment of secondary structural members.

3. Secondary Structural Members

a. Purlins and Girts

1) Purlins and girts shall be 8-inch (203 mm) or 9-1/2-inch (241 mm) deep "Z" sections, precision roll formed.

2) Outer flange of all purlins and girts shall contain factory-punched holes for panel connections.

b. Eave Struts

1) Eave struts shall be 8-inch (203 mm) or 9-1/2-inch (241 mm) in deep "C" sections.

2) Outer flange of all eave struts shall contain factory-punched holes for panel connections.

c. Bracing

1) Diagonal bracing shall be designed by the canopy manufacturer and attached to columns and roof beams.

2) Flange braces, sag angles, etc., when required, shall be supplied by the building manufacturer.

4. Structural Painting

a. Structural steel shall be shop prepared, shop primed, and field painted prior to erection. For additional requirements, see Section 09 96 00 - Protective Coating. Primer products shall be compatible with paint system specified in Section 09 96 00– Protective Coating.

1) Primary Frames - Clean all steel per SSPC-SP2. Apply one coat of water reducible alkyd primer by spray or dip method to a minimum coating thickness of 1.0 mil.

2) Secondary Structurals - Clean all steel per SSPC-SP8. Apply one coat of coil applied polyester primer to a minimum coating thickness of 0.5 mil (purlins and grits).

2.6 METAL ROOF PANELS

A. Description

1. Panels shall be roll formed to provide a width coverage of 24-inches or 36-inches (610 or 915 mm).

   a. There shall be two major corrugations, 2-inches (51 mm), spaced 12-inches (305 mm) on center or there shall be three major corrugations, 2-inches (51 mm), spaced 12-inches (305 mm) on center.

   b. There shall be minor corrugations, spaced 6-inches (152 mm) on center between and perpendicular to the major corrugations.

2. The panel endlaps shall be 6-inches (152 mm).

   a. Panels shall be of maximum length so as to minimize panel endlaps.

   b. Endlaps shall be engineered to occur over and be fastened to a secondary structural member.

   c. The upper end of all panels shall be marked for the proper location of endlap sealant.

3. Ridge assembly shall be designed to allow for expansion and contraction.

4. Eave panels shall extend beyond the building structural line.

5. Panels shall be factory pre-punched at panel ends to match pre-punched holes in the eave structural members. Panel end splices shall be factory pre-punched and pre-notched. Panel end splices shall allow for expansion and contraction of the panels.

2.7 ROOF PANEL FINISH AND COLOR

A. Finish: Exterior panel surface shall be **Butler-Cote 500 FP** (70% Kynar 500 fluoropolymer), or equal.

1. Interior surface finish shall be manufacturer's standard polyester paint finish on reverse face.

B. Color shall be selected and approved by the OWNER from manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the OWNER, at no additional cost to the OWNER.

1. Tentative color selection: Provide standard color palettes with product submittals for selection by the OWNER. Tenatively, colors shall be as follows.

Metal Roof Panels	
Exterior:	Brown
Interior:	Brown

2. The OWNER reserves the option of changing this tentative color selection during the submittal process.

3. Color shall be uniform with no variation in shade, and panels of different color batches will not be acceptable.

2.8 BUILDING ACCESSORIES

A. Accessories

1. Accessories shall be manufacturer's standard unless otherwise indicated. Location of standard accessories shall be indicated on the erection drawings.

a. All miscellaneous trim and accessories shall match adjacent panels.

b. Gutters, downspouts, and trim pieces shall be provided by the manufacturer.

c. Trim materials shall be:

1) Outside corner trim shall be of the same material and finish as the exterior of wall panel.

2) Gutters, downspouts, eave trim and gable trim shall be prepainted galvanized steel.

B. Roof Fasteners

1. Insulation, bearing plates, and panel clips shall be fastened to structural members with fasteners as per manufacturer's erection drawings, using factory pre-punched holes in structural members.

2. All connections of panels to structural members except at eave shall be by clips with moveable tabs that are seamed into the standing seam sidelap.

3. Panel clips shall be fastened to structural members with fasteners as per manufacturer's erection drawing, using factory pre-punched holes in structural members.

C. Sealants

1. Factory applied side lap sealant shall be a one part, non-skinning, non-drying, synthetic butyl elastomer.

2. Field applied hidden sealant at side laps, end laps, and flashing details shall be gun grade non-skinning butyl elastomer or polymeric non-skinning butyl tape to ensure weather tightness.

3. Exposed sealant shall be as one-part moisture curing, gun grade polyurethane as recommended in writing by the Manufacturer. Color shall match adjacent panels as approved by ENGINEER. Provide custom color as required.

D. Flashing

1. Preformed metal closures, trim pieces, flashings, sheets, clips, and associated appurtenances shall be as indicated or as otherwise required for weather tightness or completeness, and shall be of the same material, color, and finish as the adjacent panels, unless otherwise indicated.

a. The minimum face dimensions between flashing breaks shall be 12-inches (305 mm). Thermal expansion of exposed items more than 24-feet (7.3 m) in continuous length shall be accommodated and watertight expansion joints shall be provided at approved locations.

b. Expansion joints shall be fabricated as approved of materials to match the flashing.

c. Flashing and trim shall be minimum 20-gauge, formed, extruded metal fabricated with the same finish and color as the exterior face of the adjacent panels, unless otherwise indicated.

d. WORK shall be coordinated as required to insure proper flashing and seals to adjoining construction.

e. Flashing shall be provided for penetrations. Provide penetration enclosures, including hot pipe penetrations, to be weathertight. Coordinate locations of protruding pipes.

PART 3 -- EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Materials shall be delivered to Site in a dry and undamaged condition and unloaded per the manufacturer's instructions. The installer shall inspect materials for damage and stains upon arrival to the Site.

B. Store materials carefully in accordance with the manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position.

3.2 PRODUCT CONDITIONS

A. Comply with manufacturer's written instructions for environmental conditions before, during and after installation.

B. Protect surrounds WORK from damage that may result from operations under this Section.

3.3 INSPECTION

A. The CONTRACTOR shall be totally responsible for the proper performance and completion of the WORK under this Section.

B. The CONTRACTOR shall inspect materials for damage and shall confirm conformance with the specifications, erection drawings, and shop drawings prior to installation.

C. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

D. The CONTRACTOR shall verify dimensions, tolerances, and method of attachment with adjacent WORK.

1. Examine substrates, areas, and conditions where metal roof and soffit panels, system support framing, and appurtenances will be installed for compliances with the requirements for installation, taking into account tolerances, and other conditions affecting performances of installed metal panels and appurtenances.

a. Provide inserts, backing blocking, anchoring devices, and reinforcements that must be built into other WORK for the installation of metal roof and soffit panels, system support framing, and appurtenances. Coordinate delivery with other WORK to avoid delay.

b. Prior to installing the pre-engineered metal canopy the CONTRACTOR and the pre-engineered metal canopy installer shall verify final alignment of the foundation, floor slab, mechanical and electrical utilities to be in compliance with these specifications with the Contract Documents, with the erection drawings, and with the shop drawings.

2. Notify the ENGINEER in writing of conditions detrimental to the proper and timely completion of the WORK. Do not proceed with the WORK until satisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the CONTRACTOR shall indicate CONTRACTOR's acceptance of the substrate, areas, and conditions.

3.4 FABRICATION

A. The canopy shall be factory fabricated and erected to the manufacturer's written standards and shall be in accordance with AISC and MBMA standards.

B. The prefabricated canopy shall be completely fabricated and prepared for shipment including any necessary crating or bundling. All parts of the canopy shall be accurately made and true to dimension so that all parts will easily fit during installation.

3.5 PREPARATION

A. Sequence installation properly with the installation and protection of other WORK, so that neither will be damaged by the installation of the other.

3.6 INSTALLATION

A. General

1. Installation shall comply with the requirements of the Contract Documents, with applicable references, with AISC, AISI, MBMA, with the requirements of the CODE, and with manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the ENGINEER.

2. The CONTRACTOR shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

3. The CONTRACTOR shall provide separation of dissimilar materials to ensure no galvanic action occurs.

4. Horizontal lines shall be level, and vertical lines shall be plumb.

5. WORK shall be coordinated as required to insure proper flashing and seals to adjoining construction.

B. Installation and Erection: Installation and erection of the canopy shall be in accordance with the manufacturer's standards and shall be workmanship of the highest quality. No field cutting of structural parts will be permitted. Field cutting and patching of roof panels and accessories will not be permitted unless authorized by the ENGINEER. Such field modifications, when authorized, shall be performed in a manner which will not impair the appearance, weather tightness, or structural quality of the material. Erection shall be accomplished in sufficient time to meet the schedule specified.

3.7 ROOF PANELS

A. General: Apply panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line. Protect factory finishes from damage.

1. Flash and seal roof panels at eave and rake with rubber, neoprene or other closures to exclude weather.

B. Roof Panel Application

1. Panels shall be factory cut-to-length according to the erection drawings as furnished by the manufacturer.

2. Panels shall be positioned and aligned to hold the 24-inch (610 mm) or 36-inch (915 mm) module throughout the building length.

3. Pre-punched panels shall be positioned and aligned by matching the pre-punched holes in the panel with the pre-punched roof structural.

4. Panel sidelaps shall be field seamed; all sidelap sealant shall be factory applied.

5. Endlaps will be at least 6-inches (152 mm) and fastened together over and to structural members.

6. Panel sidelaps and endlaps shall be sealed with weather sealing compound to prevent the entry of capillary moisture.

7. Fasteners shall be installed with proper tools, in a workmanlike manner according to the recommendations of the Manufacturer.

3.8 WALL PANELS

A. Wall Panel Application

1. Structural system shall be plumb before wall panels are attached.

2. Panels shall be aligned and attached in accordance with the erection drawings.

3. Sidelaps shall be at least one corrugation.

4. Panels shall be closed at base by metal closure.

3.9 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the CONTRACTOR.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation of pre-engineered metal canopy and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the ENGINEER.

C. Cleaning shall be performed again immediately prior to acceptance of the WORK, as determined by the ENGINEER.

1. Cleaning shall be performed in accordance with the manufacturer's written instructions.

2. Pre-engineered metal canopy shall be protected from damage from subsequent construction operations.

D. The CONTRACTOR shall make adjustments required until accepted.

E. The CONTRACTOR shall remove scratches and blemishes to the satisfaction of the ENGINEER.

F. Damaged or defective items shall be removed and replaced at the direction of the ENGINEER.

G. When pre-engineered metal canopy WORK is completed, remove unused materials, containers, and equipment, and clean the Site of debris.

END OF SECTION

SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING 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. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V 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 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet 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 C, medium induction motor.

B. Efficiency: 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.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
1. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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 USED)

END OF SECTION

SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING 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 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout.
4. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

1. Advance Products & System, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

1. Advance Products & System, Inc.
2. CALPICO, Inc.
3. Metraflex Company.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

a. GE Construction Sealants;Momentive Performance Materials Inc.
b. Sherman-Williams Company.
c. The Dow Company.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable

(self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

    a. May National Associates, Inc..

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

    1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, and concrete walls as new slabs and walls are constructed.
    1. Cut sleeves to length for mounting flush with both surfaces.

        a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

    2. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

    1. Cut sleeves to length for mounting flush with both surfaces.
    2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
    3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

F. Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into and out of building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C.

3.3 FIELD QUALITY CONTROL

D. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

E. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 : Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6 : Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION

SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. BrassCraft Manufacturing Co.; a Masco company.
2. Keeney Manufacturing Company (The).
3. Mid-America Fittings, LLC; A Midland Industries Company.

2.2 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

C. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed rivet hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece cast brass or split-casting brass with polished, chrome-plated finish.
c. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
g. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
h. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING 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 SUMMARY

A. Section Includes:
1. Liquid-in-glass thermometers.
2. Light-activated thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.

B. Related Requirements:

1. Section 22 11 19 "Domestic Water Piping Specialties" for water meters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

a. Trerice, H.O. Co.
b. Weiss, Inc.
c. Winters Instruments – US.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 7-inch (178-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Window: Glass or plastic.
8. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

   a. Trerice, H.O. Co.
   b. Weiss, Inc.
   c. Winters Instruments – US.

2. Case: Metal; 7-inch nominal size unless otherwise indicated.
3. Scale(s): Deg F .
4. Case Form: Adjustable angle.
5. Connector: 1-1/4 inches , with ASME B1.1 screw threads.
6. Stem: Aluminum and of length to suit installation.

   a. Design for Thermowell Installation: Bare stem.

7. Display: Digital.
8. Accuracy: Plus or minus 2 deg F .

2.3 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES.

5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.4 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

    a. Ernst Flow Industries.
    b. WATTS.
    c. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi .
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

    a. Ernst Flow Industries.
    b. WATTS.
    c. Weiss Instruments, Inc.

2. Standard: ASME B40.100.
3. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi .
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Metal case, industrial-style, liquid-in-glass type.
2. Direct-mounted, light-activated type.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F .

B. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be one of the following:

1. Sealed, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Sealed, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

C. Pressure gages at suction and discharge of each domestic water pump shall be one of the following:

1. Sealed, direct-mounted, metal case.

2. Sealed, direct-mounted, plastic case.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi.

B. Scale Range for Domestic Water Piping: 0 to 100 psi.

END OF SECTION

SECTION 22 05 23.12 - BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. RPTFE: Reinforced polytetrafluoroethylene.

C. WOG: Water, oil, gas.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic water valves intended to convey or dispense water for human consumption must comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or must be certified to be in compliance with NSF 61 and NSF 372 (by an ANSI-accredited third-party certification body) that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B16.18 for cast copper solder-joint connections.
2. ASME B16.22 for wrought copper and copper alloy solder-joint connections.
3. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Type:

1. Hand Lever: For quarter-turn valves smaller than NPS 4 .

G. Valves in Insulated Piping:

1. Provide 2-inch extended neck stems.
2. Extended operating handles with nonthermal-conductive covering material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.3 BRASS BALL VALVES

A. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. NIBCO INC.
b. Red-White Valve Corp.
c. WATTS; A Watts Water Technologies Company.

2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.

6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

B. Brass Ball Valves, Two Piece with Full Port and Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Milwaukee Valve Company.
c. WATTS; A Watts Water Technologies Company.

2. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RPTFE.
9. Stem: Brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: Buna-N or EPDM.

2.4 BRONZE BALL VALVES

A. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Milwaukee Valve Company.
b. NIBCO INC.
c. WATTS; A Watts Water Technologies Company.

2. Standard: MSS SP-110; MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Threaded or soldered.
7. Seats: PTFE.
8. Stem: Bronze or brass.
9. Ball: Chrome-plated brass.
10. Port: Full.

B. Bronze Ball Valves, Two Piece with Full Port, and Bronze or Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Red-White Valve Corp.

2. Standard: MSS SP-110; MSS SP-145; IAPMO/ANSI Z1157.
3. CWP Rating: Minimum 200 psig.
4. Body Design: Two piece.
5. Body Material: Bronze.
6. Ends: Press.
7. Press-End Connections Rating: Minimum 200 psig.
8. Seats: PTFE or RTPFE.
9. Stem: Bronze or brass.
10. Ball: Chrome-plated brass.
11. Port: Full.
12. O-Ring Seal: EPDM or Buna-N.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow space for service, maintenance, and equipment removal without system shutdown.

B. Provide support to piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position to allow full valve actuation movement.

F. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

G. Adhere to manufacturer's written installation instructions. When soldering or brazing valves, do not heat valves above maximum permitted temperature. Do not use solder with melting point temperature above valve manufacturer's recommended maximum.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves exhibiting leakage.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, provide the same types of valves with higher CWP ratings.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Brass ball valves, two piece with full port, and brass trim. Provide with solder or press-connection-joint ends.
2. Bronze ball valves, two piece with full port, and bronze or brass trim. Provide with solder or press-connection-joint ends.

END OF SECTION

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SECTION 22 05 23.14 - CHECK VALVES FOR PLUMBING 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 SUMMARY

A. Section Includes:
1. Bronze swing check valves.
2. Bronze swing check valves, press ends.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.18 for solder joint.
3. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Red-White Valve Corp.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Milwaukee Valve Company.
b. NIBCO INC.
c. Red-White Valve Corp.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

C. Bronze Swing Check Valves, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Milwaukee Valve Company.
c. NIBCO INC.

2. Description:

a. Standard: MSS SP-80 and MSS SP-139.
b. CWP Rating: Minimum 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B584, bronze.
e. Ends: Press.
f. Press Ends Connection Rating: Minimum 200 psig.
g. Disc: Brass or bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.

F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered or press-ends.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze swing check valves with nonmetallic disc, Class 125, with soldered or threaded end connections.
2. Bronze swing check valves with press-end connections.

END OF SECTION

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal hanger-shield inserts.
4. Fastener systems.
5. Pipe-positioning systems.
6. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER-SHIELD INSERTS

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

1. National Pipe Hanger Corporation.
2. Pipe Shields Inc.
3. Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cooper B-line; brand of Eaton, Electrical Sector.
b. Hilti, Inc.
c. ITW Ramset/Red Head; Illinois Tool Works, Inc.

2. Indoor Applications: stainless steel.
3. Outdoor Applications: Stainless steel.

2.6 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.8 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

M. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

4. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 : 12 inches long and 0.048 inch thick.
   b. NPS 4 : 12 inches long and 0.06 inch thick.

5. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 099113 "Exterior Painting." or Section 099123 "Interior Painting."

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal hanger-shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24 , requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 , requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 , to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 .
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 .
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 .
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 .
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 .
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 .

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 .
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. C-Clamps (MSS Type 23): For structural shapes.
6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

11. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

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SECTION 22 05 33 - HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention with the following electric heating cables:

B. Self-regulating, parallel resistance.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

1. Briskheat Corporation; www.briskheat.com
2. Chromalox, Inc; www.chromalox.com
3. Nelson Heat Trace Systems
4. Omega Engineering Inc; www.omega.com
5. Thermon Inc; www.thermon.com

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, tinned, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 3 W/ft.
2. Electrical Characteristics for Single-Circuit Connection:
   a. Volts: 120.
   b. Phase: 1.

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

1. Provide warning labels indicating the presence of electric heat trace on or near each portion of pipe with heat trace applied.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Freeze Protection for Piping: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

A. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
4. Install warning labels on piping insulation where piping is equipped with electric heating cables.

B. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

C. Cables will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 22 05 48 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Restrained-spring isolators.
3. Pipe-riser resilient support.
4. Resilient pipe guides.
5. Elastomeric hangers.
6. Spring hangers.
7. Snubbers.
8. Restraints - rigid type.
9. Restraints - cable type.
10. Restraint accessories.
11. Post-installed concrete anchors.
12. Concrete inserts.

B. Related Requirements:

1. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.3 DEFINITIONS

A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic- restraint component.
3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing, UL product listing, or FM Approvals an agency acceptable to authorities having jurisdiction.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.

C. Delegated-Design Submittal:

1. For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, and concrete anchor and insert, that is required by this Section or is indicated on Drawings, submit the following:

    a. Seismic restraint, and vibration isolator, and isolation base selection: Select vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
    b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
    c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
    d. ment use.
    e. Seismic Design Calculations: Submit all input data and loading calculations prepared in "Performance Requirements" Article in "Seismic Design Calculations" Paragraph.
    f. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared in "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.
    g. Qualified Professional Engineer: All designated-design submittals for seismic calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Seismic-Restraint Detail Drawing:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths,

and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, UL, or FM Approvals, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
4. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.
5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.
6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.
7. e exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer.

C. Welding certificates.

D. Field quality-control reports:

E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16**,** Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active plumbing seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 , including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction, or experience data as permitted by ASCE/SEI 7-16.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing, UL product listing, or FM Approvals an agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design seismic load control system.

1. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-16.

B. Seismic Design Calculations:
1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.

a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.
b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.
c. Building Occupancy Category: II.
d. Building Risk Category: II.
e. Building Site Classification: D.

2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

a. Horizontal Seismic Design Force F_p: Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.
1) S_{DS} = Spectral Acceleration: 0.818. Value applies to all components on Project.
2) a_p = Component Amplification Factor: Determine for each component by Delegated-Design Contractor.

3) I_p = Component Importance Factor: Determine for each component by Delegated-Design Contractor.
4) W_p = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.
5) R_p = Component Response Modification Factor: Determine for each component by Delegated-Design Contractor.
6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.
7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.

b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.
c. Seismic Relative Displacement D_{pl}: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) D_p = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
2) I_e = Structure Importance Factor: 1.0. Value applies to all components on Project.
3) δ_{xA} = Deflection at Building Level x of Structure A: Determine for each component by Delegated-Design Contractor.
4) δ_{yA} = Deflection at Building Level y of Structure A: Determine for each component by Delegated-Design Contractor.
5) δ_{yB} = Deflection at Building Level y of Structure B: Determine for each component by Delegated-Design Contractor.h_x = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
6) h_y = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
7) Δ_{aA} = Allowable Story Drift for Structure A: Determine for each component by Delegated-Design Contractor.
8) Δ_{aB} = Allowable Story Drift for Structure B: Determine for each component by Delegated-Design Contractor.
9) h_{sx} = Story Height Used in the Definition of Allowable Drift Δ_a: Determine for each component by Delegated-Design Contractor.

d. Component Fundamental Period T_p: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:

1) W_p = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
2) g = Gravitational Acceleration: 32.17 fps^2.
3) K_p = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated-design seismic engineer.

C. Consequential Damage: Provide additional seismic and wind-force restraints for suspended plumbing components or anchorage of floor, roof or wall mounted plumbing components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential plumbing component will not cause the failure of any other essential architectural, mechanical or electrical building component.

D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load Ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric .
   a. Surface Pattern: Smooth, ribbed, or waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

2.3 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ace Mountings Co., Inc.

b. Kinetics Noise Control, Inc.
c. Mason Industries, Inc.

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Top plate with elastomeric pad.
c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.4 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- Thick Neoprene: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. California Dynamics Corporation.
b. Kinetics Noise Control, Inc.
c. Mason Industries, Inc.

2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.5 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- Thick Neoprene: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. California Dynamics Corporation.
b. Kinetics Noise Control, Inc.
c. Mason Industries, Inc.

2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.6 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. California Dynamics Corporation.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel-to-steel contact.

2.7 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. California Dynamics Corporation.
   b. Kinetics Noise Control, Inc.
   c. Mason Industries, Inc.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.8 SNUBBERS

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

1. Kinetics Noise Control, Inc.
2. Mason Industries, Inc.
3. Vibration Management Corp.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2015 or 2018 IBC. Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
2. Anchors in Masonry: Design in accordance with TMS 402.
3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
4. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

2.9 RESTRAINTS - RIGID TYPE

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

1. California Dynamics Corporation.
2. Hilti, Inc.
3. TOLCO Incorporated.

B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.10 RESTRAINTS - CABLE TYPE

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

1. Cooper B-line; brand of Eaton, Electrical Sector.
2. Loos & Co. Inc.
3. VMC GROUP.

B. Seismic-Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

2.11 RESTRAINT ACCESSORIES

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

1. Cooper B-line; brand of Eaton, Electrical Sector.
2. Hilti, Inc.
3. TOLCO Incorporated.

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.12 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. Mason Industries, Inc.
c. Powers Fasteners.

2. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. Mason Industries, Inc.
c. Powers Fasteners.

2. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications

and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.13 CONCRETE INSERTS

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

1. Hilti, Inc.
2. Mason Industries, Inc.
3. Powers Fasteners.

B. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS 58.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static and seismic load within specified loading limits.

3.3 INSTALLATION OF VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraintdevices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

F. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet .

G. Install seismic-restraint cables so they do not bend across edges of adjacent equipment or building structure.

H. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

I. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

J. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

K. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

L. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 221116 "Domestic Water Piping" and Section 221119 "Domestic Water Piping Specialties" for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. Perform tests and inspections.
   2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
   4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
   5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   6. Test to 90 percent of rated proof load of device.
   7. Measure isolator restraint clearance.
   8. Measure isolator deflection.
   9. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve-numbering scheme.

E. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: stainless steel, 0.025-inch or anodized aluminum, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
3. Letter Color: White
4. Background Color: Black.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances of up to 72 inches , and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Brady Corporation.
   b. Brimar Industries, Inc.
   c. Seton Identification Products; a Brady Corporation company.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter Color: White
4. Background Color:Black.
5. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
8. Fasteners: Stainless steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedules: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plan, detail, and schedules) and the Specification Section number and title where equipment is specified.

1. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1. Pipe size.
2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 VALVE TAGS

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

1. Brady Corporation.
2. Seton Identification Products; a Brady Corporation company.
3. emedco.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch or anodized aluminum, 0.031-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass link chain or beaded chain.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:
1. Domestic Cold-Water Piping: White letters on an ANSI Z535.1 safety-green background.
2. Domestic Hot-Water Piping: White letters on an ANSI Z535.1 safety-green background
3. Domestic Hot-Water Return Piping White letters on an ANSI Z535.1 safety-green background.
4. Sanitary Waste Piping: White letters on a black background.
5. Nonpotable Cold Water: Black letters on an ANSI Z535.1 safety-yellow background.

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Domestic Cold Water: 1-1/2 inches , round.
b. Domestic Hot Water: 1-1/2 inches , round.
c. Domestic Hot-Water Return: 1-1/2 inches , round.
d. Nonpotable Cold Water: 1-1/2 inches , round.

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

END OF SECTION

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SECTION 22 07 19 - PLUMBING PIPING INSULATION

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. Section includes insulating the following plumbing piping services:

1. Domestic cold-water and well water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

B. s, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Mansville.
   b. Knauf Insulation.
   c. Owens Corning.
2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ-SSL.
3. 850 deg F .
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA.
   b. Armacell LLC.
   c. Foster Brand; H. B. Fuller.
2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F .
4. Service Temperature Range: 40 to 200 deg F .
5. Color: Black.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller.

D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Mon-Eco Industries, Inc.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Johns Manville; a Berkshire Hathaway company.
    b. Speedline Corporation.
    c. The Dow Chemical Company.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Knauf Insulation.
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F .
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Knauf Insulation.
2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F .
4. Color: White.

2.5 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Vimasco Corporation.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Mon-Eco Industries, Inc.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 58 to plus 176 deg F .
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
    c. Mon-Eco Industries, Inc.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F .
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F .
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. , in a Leno weave, for pipe.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller.
b. Vimasco Corporation.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. .

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Alpha Associates, Inc.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. P.I.C. Plastics, Inc.
    c. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209 , Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
    d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.
    e. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Owens Corning.
    b. Polyguard Products, Inc.

F. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of

a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco-embossed aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. MFM Building Products Corp.
    b. Polyguard Products, Inc.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. 3M Industrial Adhesives and Tapes Division.
    b. Ideal Tape Co., Inc., an American Biltrite Company.
    c. Knauf Insulation.
2. Width: 3 inches .
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. 3M Industrial Adhesives and Tapes Division.
    b. Ideal Tape Co., Inc., an American Biltrite Company.
    c. Knauf Insulation.
2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. 3M Industrial Adhesives and Tapes Division.
    b. Ideal Tape Co., Inc., an American Biltrite Company.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.

5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. 3M Industrial Adhesives and Tapes Division.
   b. Ideal Tape Co., Inc., an American Biltrite Company.
   c. Knauf Insulation.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville; a Berkshire Hathaway company.
   b. RPR Products, Inc.
2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire Products.
   b. Johns Manville; a Berkshire Hathaway company.
   c. RPR Products, Inc.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers,:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Plumberex Specialty Products, Inc.
   b. ProFlo; a Ferguson Enterprises, Inc. brand.
   c. Truebro; IPS Corporation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures,:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProFlo; a Ferguson Enterprises, Inc. brand.
   b. Truebro; IPS Corporation.
   c. Zurn Industries, LLC.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. lation application.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches . Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches .
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. s vapor barrier.
7. vapor barrier.
8. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
9. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
10. ces and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

11. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

E. Install removable insulation covers. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. ulation and jacket.
4. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
5. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
6. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

B. terior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

C. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

D. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

E. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

Retain first paragraph below to require Contractor to hire an independent testing agency.

A. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water and Well Water:

1. NPS 1-1/2 and Smaller: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1/2 inch (13 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
2. NPS 2 (DN 32) and Larger: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1 inch (25 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/2 and Smaller: Insulation shall be one of the following:
   a. Flexible Elastomeric: **1 inch** thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. NPS 2 and Larger: Insulation shall be one of the following:
   a. Flexible Elastomeric: 1-1/2 inch thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.

C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Flexible Elastomeric: 1/2 inch (13 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F :

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Flexible Elastomeric: 1 inch thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Flexible Elastomeric: 2 inches thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Flexible Elastomeric: 2 inches thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:

1. All Pipe Sizes: Insulation shall be one of the following:

   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. PVC: 30 mils thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1. None.

D. Piping, Exposed:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

3.16 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

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SECTION 22 11 16 - DOMESTIC WATER 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 SUMMARY

A. Section Includes:

1) Copper tube and fittings.
2) PEX tube and fittings.
3) Piping joining materials.
4) Encasement for piping.
5) Transition fittings.
6) Dielectric fittings.

1.3 ACTION SUBMITTALS

A. Product Data:

1) Pipe and tube.
2) Fittings.
3) Joining materials.
4) Transition fittings.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. M model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

C. System purging and disinfecting activities report.

D. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) and ASTM B88, Type L (ASTM B88M, Type B).

B. Annealed-Temper Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) and ASTM B88, Type L (ASTM B88M, Type B).

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

G. Wrought Copper Unions: ASME B16.22.

H. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Elkhart Products Corporation.
    b. NIBCO Inc.
    c. Viega LLC.
2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
3. Minimum 200-psig working-pressure rating at 250 deg F .

2.3 PEX TUBE AND FITTINGS

1) Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. Elkhart Products Corporation.
    b. NIBCO Inc.
    c. Viega LLC.

B. Tube Material: PEX plastic according to ASTM F876 and ASTM F877.

C. Fittings: ASTM F1807, metal insert and copper crimp rings.

D. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F876; with plastic or corrosion-resistant-metal valve for each outlet.

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys.

D. Flux: ASTM B813, water flushable.

2.5 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Form: tube.

C. Color: Black or natural.

2.6 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. WATTS.
   b. Wilkins.
   c. Zurn Industries.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F .
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

C. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Advance Products & Systems Inc.
    b. Central Plastics Company.
    c. Pipe Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig .
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
1. Annealed-temper copper tube, ASTM B88, Type K ; wrought-copper, solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:
1. Drawn-temper or annealed-temper copper tube, ASTM B88, Type L ; wrought-copper, solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
1. Drawn-temper copper tube, ASTM B88, Type L ; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Drawn-temper copper tube, ASTM B88, Type L ; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. PEX tube, NPS 1 and smaller.
    a. Fittings for PEX tube:
        1) ASTM F1807, metal insert and copper crimp rings.
        2) ASTM F1960, cold expansion fittings and reinforcing rings.
        3) ASSE 1061, push-fit fittings.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 , shall be one of the following:

1. Drawn-temper copper tube, ASTM B88, Type L ; cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Drawn-temper copper tube, ASTM B88, Type L ; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Drawn-temper copper tube, ASTM B88, Type L ; grooved-joint, copper-tube appurtenances; and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A674 or AWWA C105/A21.5.

D. Install valves according to the following:

1. Section 220523.12 "Ball Valves for Plumbing Piping."
2. Section 220523.14 "Check Valves for Plumbing Piping."

E. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

F. Install domestic water piping level without pitch and plumb.

G. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

H. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

I. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

L. Install piping to permit valve servicing.

M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install PEX tubing with loop at each change of direction of more than 90 degrees.

Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

R. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."

S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."

D. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

E. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

F. bolts.

G. Joints for PEX Tubing, ASTM: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.

H. Joints for PEX Tubing, ASSE: Join according to ASSE 1061 for push-fit fittings.

I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition unions.

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 : Use dielectric flanges.

3.7 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Support horizontal piping within 12 inches of each fitting.

F. Support vertical runs of copper piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Support vertical runs of PEX tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:
a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION

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SECTION 22 11 19 - DOMESTIC WATER PIPING SPECIALTIES

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. Section Includes:

1) Vacuum breakers.
2) Backflow preventers.
3) Water pressure-reducing valves.
4) Balancing valves.
5) Temperature-actuated, water mixing valves.
6) Strainers for domestic water piping.
7) Outlet boxes.
8) Hose bibbs.
9) Wall hydrants.
10) Drain valves.
11) Water-hammer arresters.
12) Trap-seal primer device.
13) Trap-seal primer systems.

B. Related Requirements:

1) Section 220519 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
2) Section 221116 "Domestic Water Piping" for water meters.
3) Section 224500 "Emergency Plumbing Fixtures" for water tempering equipment.

1.3 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1) Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Test and inspection reports.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Apollo Flow Controls.
b. WATTS.
c. Zurn Industries, LLC.

2) Standard: ASSE 1001.
3) Size: NPS 1/4 to NPS 3 , as required to match connected piping.
4) Body: Bronze.
5) Inlet and Outlet Connections: Threaded.
6) Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. WATTS.
   b. Woodford Manufacturing Company.
   c. Zurn Industries, LLC.

2) Standard: ASSE 1011.
3) Body: Bronze, nonremovable, with manual drain.
4) Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5) Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Ames Fire & Waterworks.
   b. FEBCO.
   c. Zurn Industries, LLC.
   d. Watts

2) Standard: ASSE 1013.
3) Operation: Continuous-pressure applications.
4) Pressure Loss: 12 psig maximum, through middle third of flow range.
5) Body: Bronze for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.
6) End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7) Configuration: Designed for horizontal, straight-through flow.
8) Accessories:

   a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Ames Fire & Waterworks.
   b. FEBCO.
   c. Zurn Industries, LLC.
   d. Watts

2) Standard: ASSE 1015.
3) Operation: Continuous-pressure applications unless otherwise indicated.
4) Pressure Loss: 6 psig maximum, through middle third of flow range.

5) Body: cast silicon copper alloy for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.
6) End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7) Configuration: Designed for horizontal, straight-through flow.
8) Accessories:

a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Cash Acme.
b. WATTS.
c. Zurn Industries, LLC.
2) Standard: ASSE 1003.
3) Pressure Rating: Initial working pressure of 150 psig .
4) Body: Bronze for NPS 2 and smaller; bronze for NPS 2-1/2 and NPS 3 .
5) Valves for Booster Heater Water Supply: Include integral bypass.
6) End Connections: Threaded or solder for NPS 2 and smaller; flanged or solder for NPS 2-1/2 and NPS 3 .

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1) Manufacturers: Subject to compliance with requirements, **provide products by one of the following**:

a. Apollo Flow Controls.
b. Milwaukee Valve Company.
2) Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3) Pressure Rating: 400-psig minimum CWP.
4) Size: NPS 2 or smaller.
5) Body: Copper alloy.
6) Port: Standard or full port.
7) Ball: Chrome-plated brass or stainless steel.
8) Seats and Seals: Replaceable.
9) End Connections: Solder joint or threaded.
10) Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Primary, Thermostatic, Water Mixing Valves:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Acorn Controls.
   b. Leonard Valve Company.
   c. POWERS; a WATTS Brand.

2) Standard: ASSE 1017.
3) Pressure Rating: 125 psig minimum unless otherwise indicated.
4) Type: Exposed-mounted, thermostatically controlled, water mixing valve.
5) Material: Bronze body with corrosion-resistant interior components.
6) Connections: Threaded union inlets and outlet.
7) Accessories: Programmable temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control setpoint.
8) Tempered-Water Setting: 120 deg F .
9) Valve Finish: Rough bronze.
10) Piping Finish: Copper.

B. Individual-Fixture, Shower Tempering Valves:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Acorn Controls.
   b. Leonard Valve Company.
   c. POWERS; a WATTS Brand.

2) Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3) Pressure Rating: 125 psig minimum unless otherwise indicated.
4) Material: Bronze body with corrosion-resistant interior components.
5) Temperature Control: Adjustable.
6) Finish: Chrome plated.
7) Tempered-Water Setting: 105 deg F .

C. Individual-Fixture, Lavatory Tempering Valves:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Acorn Controls.
   b. Leonard Valve Company.
   c. POWERS; a WATTS Brand.

2) Standard: ASSE 1070, thermostatically controlled, water tempering valve.
3) Pressure Rating: 125 psig minimum unless otherwise indicated.
4) Material: Brass body with corrosion-resistant interior components.
5) Temperature Control: Adjustable.
6) Tempered-Water Setting: 105 deg F .

D. Individual-Fixture, Emergency Eyewash Tempering Valves:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Acorn Controls.
b. Leonard Valve Company.
c. POWERS; a WATTS Brand.

2) Standard: ASSE 1071, thermostatically controlled, water tempering valve.
3) Pressure Rating: 125 psig minimum unless otherwise indicated.
4) Material: Bronze body with corrosion-resistant interior components.
5) Temperature Control: Adjustable.
6) Finish: Chrome plated.
7) Tempered-Water Setting: 80 deg F .

2.8 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Titan Flow Control, Inc.
b. WATTS.
c. Zurn Industries, LLC.

2) Pressure Rating: 125 psig minimum unless otherwise indicated.
3) Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
4) End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5) Screen: Stainless steel with round perforations unless otherwise indicated.
6) Perforation Size:

a. Strainers NPS 2 and Smaller: 0.020 inch .
b. Strainers NPS 2-1/2 to NPS 4 : 0.045 inch .

7) Drain: Factory-installed, hose-end drain valve.

2.9 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. IPS Corporation.
b. Oatey.
c. Sioux Chief.

2) Mounting: Recessed.
3) Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
4) Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.

5) Drain Outlet Connection: NPS 2 .
6) Accessory: Water hammer arresters.
7) Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.

2.10 HOSE BIBBS

A. Hose Bibbs:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R. Smith Mfg. Co.
b. WATTS.
c. Woodford Manufacturing Company.

2) Standard: ASSE 1052.
3) Body Material: Brass.
4) Seat: Brass, replaceable.
5) Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
6) Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7) Pressure Rating: 125 psig .
8) Double Check Valve: Integral nonremovable, drainable, hose-connection double check valve complying with ASSE 1052.
9) Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10) Finish for Service Areas: Chrome or nickel plated.
11) Finish for Finished Rooms: Chrome or nickel plated.
12) Operation for Equipment Rooms: Wheel handle or operating key.
13) Operation for Service Areas: Wheel handle.
14) Operation for Finished Rooms: Operating key.
15) Include operating key with each operating-key hose bibb.
16) Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.11 WALL HYDRANTS

A. Nonfreeze Vacuum Breaker Wall Hydrants:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Jay R. Smith Mfg. Co.
b. Woodford Manufacturing Company.
c. Zurn Industries, LLC.

2) Standard: ASSE 1019, Type B.
3) Type: Automatic draining with integral anti-siphon vacuum breaker.
4) Vacuum Breaker: Anti-siphon, integral, approved under ASSE 1011.
5) Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
6) Pressure Rating: 125 psig .
7) Operation: Loose key.

8) Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
9) Inlet: NPS 1/2 or NPS 3/4 .
10) Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1) Standard: MSS SP-110 for standard-port, two-piece ball valves.
2) Pressure Rating: 400-psig minimum CWP.
3) Size: NPS 3/4 .
4) Body: Copper alloy.
5) Ball: Chrome-plated brass.
6) Seats and Seals: Replaceable.
7) Handle: Vinyl-covered steel.
8) Inlet: Threaded or solder joint.
9) Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.13 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Jay R. Smith Mfg. Co.
b. Precision Plumbing Products.
c. WATTS.

2) Standard: ASSE 1010 or PDI-WH 201.
3) Type: Piston.
4) Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.14 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Jay R. Smith Mfg. Co.
b. Sioux Chief.
c. Zurn Industries, LLC.

2) Standard: ASSE 1018.
3) Pressure Rating: 125 psig minimum.
4) Body: Bronze.
5) Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6) Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

7) Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.15 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Precision Plumbing Products.
b. Sioux Chief Manufacturing Company, Inc.
c. Zurn Industries, LLC.
d. Jay R Smith Mfg. Co.

2) Standard: ASSE 1044.
3) Inlet Size: NPS 1/2, ASTM B88, Type L ; copper, water tubing.
4) Cabinet: Recessed-mounted steel box with stainless steel cover.
5) Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120 V ac power.

a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

6) Vacuum Breaker: ASSE 1001.
7) Number Outlets: Four to Twelve.
8) Size Outlets: NPS 1/2 or NPS 5/8 .

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1) Locate backflow preventers in same room as connected equipment or system.
2) Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3) Do not install bypass piping around backflow preventers.

B. Water Regulators: Install with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gauges on inlet and outlet.

C. Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.

D. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

E. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.

F. Y-Pattern Strainers: For water, install on supply side of each water pressure-reducing valve and pump.

G. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."

H. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

I. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

J. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1) Vacuum breakers.
2) Backflow preventers.
3) Water pressure-reducing valves.
4) Balancing valves.
5) Temperature-actuated, water mixing valves.
6) Outlet boxes.
7) Wall hydrants.
8) Trap-seal primer device.
9) Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections.

1) Test each reduced-pressure-principle backflow preventer and double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
2) Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3) Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

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SECTION 221123.13 - DOMESTIC-WATER PACKAGED BOOSTER PUMPS

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. Section Includes:

1. Simplex, variable-speed booster pumps.

B. Related Requirements:

1. Section 221123.21 "Inline Domestic Water Pumps" for domestic-water circulation pumps.

1.3 DEFINITIONS

A. PID: Proportional Integral Derivative.

B. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For booster pumps.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For domestic-water packaged booster pumps.

1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for booster pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For booster pumps to include in emergency, operation, and maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Retain protective coatings and flange's protective covers during storage.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

B. Seismic Performance: Booster pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the booster pump will remain in place without separation of any parts from the booster pump when subjected to the seismic forces specified."

2.2 SIMPLEX, VARIABLE-SPEED BOOSTER PUMPS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Grundfos
2. Armstrong

B. Description: Factory-assembled and -tested, fluid-handling system for domestic water, with pump, piping, valves, specialties, and controls, and mounted on base.

C. Pump:

1. Type: End suction as defined in HI 1.1-1.2 and HI 1.3 for end-suction, close-coupled, variable-speed, overhung-impeller, centrifugal pump.
2. Impeller: Closed, stainless steel; statically and dynamically balanced and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve and deflector.
4. Seal: Mechanical.
5. Orientation: Mounted vertically.

D. Motor:

1. Variable speed, with grease-lubricated, ball-bearings, and directly mounted to pump casing. Select motor that will not overload through full range of pump performance curve.

E. Valves:

1. Shutoff Valves NPS 2 and Smaller: two-piece, full-port ball valve, in pump suction and discharge piping.
2. Shutoff Valves NPS 2-1/2 and Larger: lug-type butterfly valve, in pump suction and discharge piping.
3. Check Valve NPS 2 and Smaller: Silent or swing type in pump discharge piping.
4. Check Valve NPS 2-1/2 and Larger: Silent type in pump discharge piping.
5. Thermal-Relief Valve: Temperature-and-pressure relief type in pump discharge piping.

F. Dielectric Fittings: With insulating material to isolate joined dissimilar metals.

G. Hydropneumatic Tank: Precharged, diaphragm or bladder tank made of materials complying with NSF 61 and NSF 372.

H. VFC: Comply with Section 262923 "Variable-Frequency Motor Controllers."

I. VFC: Serving each pump in pump array.

1. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
2. Unit Operating Requirements:

a. Internal Adjustability:

1) Minimum Speed: 5 to 25 percent of maximum rpm.
2) Maximum Speed: 80 to 100 percent of maximum rpm.
3) Current Limit: 30 to minimum of 150 percent of maximum rating.

b. Self-Protection and Reliability Features:

1) Surge suppression.
2) Loss of input signal protection.
3) Under- and overvoltage trips.

4) VFC and motor overload/overtemperature protection.
5) Critical frequency rejection.
6) Loss-of-phase protection.
7) Reverse-phase protection.
8) Motor-overtemperature fault.

c. Control Signal Interface: Electric.
d. PID control interface.

3. Line Conditioning:

a. Input line conditioning.
b. Output filtering.
c. EMI/RFI filtering.

4. High-suction-pressure cutout.
5. Low-discharge-pressure cut-in.
6. High-discharge-pressure cut-out.

J. Base: Structural steel.

K. Capacities and Characteristics:

1. Minimum Pressure Rating: 60 psig.
2. Booster-Pump Capacity: 15 gpm.
3. Speed: 4000 rpm.
4. Inlet Size: 1 NPS.
5. Outlet Size: 1 NPS.
6. Electrical Characteristics:

a. Motor Horsepower: 1.5 hp.
b. Volts: 208 V.
c. Phases: Three.
d. Hertz: 60 Hz.

L. Hydropneumatic Tank:

2. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. PROFLO; www.ferguson.com
b. Amtrol; www.amtrol.com

3. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
4. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber bladder. Include air precharge to minimum system-operating pressure at tank.
5. Construction:
a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for booster pumps to verify actual locations of piping connections before booster-pump installation.

3.2 INSTALLATION

A. Booster-Pump Mounting:

1. Install booster pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

B. Support connected domestic-water piping so weight of piping is not supported by booster pumps.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
B. Booster-Pump Piping Connections: Connect domestic-water piping to booster pumps. Install suction and discharge pipe equal to or greater than size of system suction and discharge piping.
1. Install shutoff valves on piping connections to booster-pump suction and discharge piping. Install ball, butterfly, or gate valves same size as suction and discharge piping. Comply with requirements for general-duty valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," Section 220523.13 "Butterfly Valves for Plumbing Piping," and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Install union, flanged, or grooved-joint connections on suction and discharge piping at connection to domestic-water piping. Comply with requirements for unions and flanges specified in Section 221116 "Domestic Water Piping."
3. Install flexible connectors, same size as piping, on piping connections to booster-pump suction and discharge piping. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."
4. Where installing piping adjacent to booster pumps, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.
B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
   2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections with the assistance of a factory-authorized service representative.

   1. Perform visual and mechanical inspection.
   2. Leak Test: After installation, charge booster pump and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start booster pumps to confirm proper motor rotation and booster-pump operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Pumps and controls will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust booster pumps to function smoothly, and lubricate as recommended by manufacturer.
B. Adjust pressure set points.
C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting booster pump to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 221123.13

SECTION 22 11 23.21 - INLINE, DOMESTIC-WATER PUMPS

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. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, separately coupled centrifugal pumps.
3. Horizontally mounted, in-line, close-coupled centrifugal pumps.
4. Vertically mounted, in-line, close-coupled centrifugal pumps.

B. Related Requirements:

1. Section 221123.13 "Domestic-Water Packaged Booster Pumps" for booster systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. acent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

C. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

D. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.0.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grundfos Pumps Corporation.
2. Taco Comfort Solutions.
3. WILO USA LLC - WILO Canada Inc.
4. Armstrong Fluid Solutions

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: 150 psig .
3. Maximum Continuous Operating Temperature: 220 deg F .
4. Casing: Stainless steel, with threaded or companion-flange connections.
5. Impeller: Noryl.
6. Motor: Three speed.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F .
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 24 V ac .
7. Settings: Start pump at 110 deg F and stop pump at 120 deg F.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Install thermostats in hot-water return piping.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:

1. Section 22 05 23.12 - Ball Valves for Plumbing Piping.
2. Section 22 05 23.14 - Check Valves for Plumbing Piping.
3. Install pressure gauge at suction of each pump and pressure gauge at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.
b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

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SECTION 22 13 16 - SANITARY WASTE AND VENT 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 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Copper tube and fittings.
5. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water .

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 74, Service class(es).

C. Gaskets: ASTM C 564, rubber.

D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AB & I Foundry; a part of the McWane family of companies.
2. Charlotte Pipe and Foundry Company.
3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Charlotte Pipe and Foundry Company.
    b. Ideal Tridon Group.
    c. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

2.6 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.7 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company, LLC; a division of MCP Industries.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

3. Dielectric Flanges:
a. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: **125 psig minimum at 180 deg F**.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:
a. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: [**150 psig**.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. 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.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook.

P. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

   a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
   b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

   a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.

3.5 VALVE INSTALLATION

A. Comply with requirements in Section 220523.12 "Ball Valves for Plumbing Piping," and Section 220523.14 "Check Valves for Plumbing Piping" for general-duty valve installation requirements.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

E. Support vertical runs of cast iron and **copper** soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water .
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg .
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.11 PIPING SCHEDULE

A. Flanges may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
4.
5. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
3. Copper Type DWV tube, copper drainage fittings, and soldered joints.
   a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M ; copper pressure fittings; and soldered joints.
4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Underground, soil, waste, and vent piping NPS 3 and smaller shall be any of the following:

1. **Extra Heavy** class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; **heavy-duty** hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Underground, soil and waste piping NPS 4 and larger shall be any of the following:
1. Ductile-iron, push-on-joint piping and push-on joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

END OF SECTION

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SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES

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. Section Includes:
   1. Cleanouts.
   2. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:
   1. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
   2. Section 077200 "Roof Accessories" for preformed flashings.
   3. Section 078413 "Penetration Firestopping" for through-penetration firestop assemblies.

1.3 DEFINITIONS

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Show fabrication and installation details for frost-resistant vent terminals.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. WATTS; A Watts Water Technologies Company.
   c. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, cast-iron or bronze plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. Sioux Chief Manufacturing Company, Inc.
   c. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Spigot or No-Hub.
8. Closure: Brass plug with tapered threads .
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Medium Duty.
13. Riser: ASTM A74, Service Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. WATTS; A Watts Water Technologies Company.

c. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
   a. Cast iron.
   b. Countersunk head.
   c. Drilled and threaded for cover attachment screw.
   d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
7. Wall Access, Frame and Cover: Square, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Floor-Drain, Trap-Seal Primer Fittings :

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

C. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

D. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

E. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

F. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

G. Install wood-blocking reinforcement for wall-mounting-type specialties.

H. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 33 00 - ELECTRIC, DOMESTIC-WATER HEATERS

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. Section Includes:

1. Domestic-water heater accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

M model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.

B. Seismic Qualification Data: Certificates, for commercial domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of commercial, electric, domestic-water heater.

D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

E. Source quality-control reports.

F. Field quality-control reports.

G. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include emergency, operation, and maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.

B. Commercial, Electric, Storage, Domestic-Water Heaters:

   a. Storage Tank: Three years.
   b. Controls and Other Components: One year.

2. Expansion Tanks: Three years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Seismic Performance: Commercial, electric, domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Component Importance Factor: 1.0.

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. AO Smith; www.hotwater.com
    b. Bradford White Corporation; www.bradfordwhite.com
    c. Rheem Manufacturing Company; www.rheem.com

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: UL 1453.
4. Storage-Tank Construction: Non-ASME-code, steel vertical arrangement.

    a. Tappings: Factory fabricated of materials compatible with tank and piping connections. Attach tappings to tank before testing.

        1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
        2) NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges, and in accordance with ASME B16.24 for copper and copper-alloy flanges.

    b. Pressure Rating: 150 psig.
    c. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining material into tappings.

5. Factory-Installed, Storage-Tank Appurtenances:

    a. Anode Rod: Replaceable magnesium.
    b. Drain Valve: Corrosion-resistant metal with hose-end connection.
    c. Insulation: Comply with ASHRAE/IES 90.1.
    d. Jacket: Steel with enameled finish or high-impact composite material.
    e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
    f. Temperature Control: Adjustable thermostat.
    g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.
    h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. PROFLO; www.ferguson.com
b. Amtrol; www.amtrol.com

2. Source Limitations: Obtain domestic-water expansion tanks from single source from single manufacturer.
3. Description: Steel pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

C. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Install electric, domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."

C. Install commercial, electric, domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend domestic-water heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

F. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains.

G. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill electric, domestic-water heaters with water.

J. Charge domestic-water expansion tanks with air to required system pressure.

K. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters. Training shall be a minimum of one hour(s).

END OF SECTION

SECTION 22 42 13.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall-mounted water closets.
   2. Flushometer valves.
   3. Toilet seats.
   4. Supports.

1.2 DEFINITIONS

A. Standard-Efficiency Flush Volume: 1.6 gal. per flush.

B. High-Efficiency Flush Volume: 1.28 gal. or less per flush.

C. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

A. Product Data:

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Flushometer-Valve Repair Kits: Two of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
5. Comply with ASME A112.6.1M for water-closet supports.
6. Comply with ICC A117.1 for ADA-compliant water closets.
7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:
   a. American Standard, Inc; www.americanstandard.com
   b. Kohler Co; www.kohler.com
   c. PROFLO; www.ferguson.com
   d. Sloan Valve Company; www.sloan.com
   e. Zurn Industries; www.zurn.com
2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:

   a. Material: Vitreous china.
   b. Type: Siphon jet.
   c. Style: Flushometer valve.
   d. Mounting Height: ADA compliant.
   e. Rim Contour: Elongated.
   f. Water Consumption: 1.28 gal. per flush.
   g. Spud Size and Location: NPS 1-1/2 ; top.
   h. Color: White.

4. Flushometer Valve: Diaphragm, Solenoid Actuated.
5. Toilet Seat: Elongated rim, open front.
6. Support: Water-closet carrier.

2.3 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Solenoid Actuated:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. American Standard.
   b. Kohler.
   c. Sloan.
2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Style: Exposed.

7. Exposed Flushometer-Valve Finish: Chrome-plated.

8. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
9. Trip Mechanism: Hard-wired, control-voltage electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
10. Consumption: 1.28 gal. per flush.
11. Minimum Inlet: NPS 1.
12. Minimum Outlet: NPS 1-1/4.

2.4 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:
   a. American Standard, Inc; www.americanstandard.com
   b. Bemis Manufacturing Company; www.bemismfg.com
   c. PROFLO; www.ferguson.com
   d. Zurn Industries; www.zurn.com
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front .
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Antimicrobial.

2.5 SUPPORTS

A. Water-Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Josam.
   b. JR Smith.
   c. Zurn.
2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
5. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

3.7 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.13 - COMMERCIAL LAVATORIES

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. Section Includes:

1. Vitreous-china, wall-mounted lavatories.
2. Automatically operated lavatory faucets.
3. Supply fittings.
4. Waste fittings.
5. Lavatory supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

A. Lavatory - Vitreous China, Wall Mounted, with Back:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. American Standard.
   b. Kohler.
   c. Sloan.

2. Fixture:

   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For wall hanging.
   c. Nominal Size: Rectangular, 20 by 18 inches.
   d. Faucet-Hole Punching: One hole.
   e. Faucet-Hole Location: Top.
   f. Color: White.
   g. Mounting Material: Sealant and undercounter mounting kit.

3. Faucet: Automatically Operated Lavatory Faucets.
4. Support: Type II, concealed-arm lavatory carrier.
5. Lavatory Mounting Height: Standard or Handicapped/elderly in accordance with ICC A117.1.

2.2 AUTOMATICALLY OPERATED LAVATORY FAUCETS

A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Lavatory Faucets - Automatic Type: Hardwired Electronic Sensor Operated, Nonmixing:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. American Standard, Inc; www.americanstandard.com
b. Hydrotek International, Inc; www.hydrotekintl.com
c. Kohler Co; www.kohler.com
d. PROFLO; www.ferguson.com
e. Sloan Valve Company; www.sloan.com

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 0.5 gpm.
9. Mounting Type: Deck, concealed.
10. Spout: Rigid type.
11. Spout Outlet: Vandal Resistant Aerator or Laminar flow.
12. Drain: Not part of faucet.

2.3 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Wheel handle.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.4 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/4.
2. Material:

    a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.
    b. Stainless steel, two-piece trap and swivel elbow with 0.012-inch thick stainless steel tube to wall, and stainless steel wall flange.

2.5 LAVATORY SUPPORTS

A. Lavatory Carrier:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Josam.
    b. JR Smith.
    c. Zurn.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.

B. Examine counters and walls for suitable conditions where lavatories will be installed.

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

3.2 INSTALLATION

A. Install lavatories level and plumb in accordance with roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

3.6 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.16 - COMMERCIAL SINKS

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. Section Includes:

1. Service sinks.
2. Kitchen/utility sinks.
3. Manually operated sink faucets.
4. Supply fittings.
5. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sinks and faucets to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE SINKS

A. Service Sinks - Terrazzo, Floor Mounted: <Insert drawing designation>.

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. American Bath Group; www.americanbathgroup.com
b. American Standard, Inc; www.americanstandard.com
c. PROFLO; www.ferguson.com
d. Zurn Industries, LLC; www.zurn.com
e. Fiat Products; www.fiatproducts.com

2. Fixture:

a. Material: Marble chips cast in portland cement to produce a compressive strength of not less than 3000 psi (20.7 MPa), seven days after casting.
b. Shape: Square.
c. Nominal Size: 30 by 30 inches
d. Height: 6 inches.
e. Tiling Flange: Not required.
f. Rim Guard: On front top surfaces.
g. Color: Not applicable.
h. Drain: Grid with NPS 3 outlet.

3. Mounting: On floor and flush to wall.
4. Faucet: Service Sink Faucet.

2.2 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. Acorn Engineering Company; www.acorneng.com
b. American Standard, Inc; www.americanstandard.com
c. Elkay Manufacturing Company; www.elkay.com
d. PROFLO; www.ferguson.com
e. Zurn Industries, LLC; www.zurn.com

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Stainless steel, self-rimming, sound-deadened unit.
c. Number of Compartments: One.
d. Overall Dimensions: 27 by 22 inches.

e. Material: 18 gauge, Type 304 stainless steel.
f. Compartment:

1) Dimensions: 27 by 22 inches.
2) Drain: Grid with NPS 2 tailpiece and twist drain.
3) Drain Location: Centered in compartment.
4) Depth: Wheelchair accessible.

4. Faucet(s): Manually Operated Sink Faucets.

a. Kitchen Sink Faucet

1) Number Required: One.
2) Faucet-Hole Location: On countertop, centered.

b. Kitchen Sink Instant Hot Water Faucet

3) Number Required: One.
4) Faucet-Hole Location: On countertop, 4 inch right off-center.

5. Supply Fittings:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

1) Operation: Wheel handle.
2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

6. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):

1) Size: NPS 2.
2) Material:

a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

c. Continuous Waste:

1) Size: NPS 2.
2) Material: Chrome-plated, 17-gauge brass tube.

7. Mounting: On counter with sealant.

B. Kitchen/Utility Sinks - Stainless Steel, Freestanding Single Compartment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. Acorn Engineering Company; www.acorneng.com
b. American Standard, Inc; www.americanstandard.com
c. Elkay Manufacturing Company; www.elkay.com
d. PROFLO; www.ferguson.com
e. Zurn Industries, LLC; www.zurn.com

2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

a. Standards:

1) ASME A112.19.3/CSA B45.4.
2) NSF 2.

b. Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
c. Number of Compartments: One.
d. Overall Dimensions: 27 by 27 inches.
e. Material: 14 gauge, Type 304 stainless steel.
f. Compartment:

1) Dimensions: 24 by 24 inches.
2) Drain: NPS 2 tailpiece and twist drain.
3) Drain Location: Centered in compartment.

4. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
5. Faucet(s): Manually Operated Hose Bibb Faucet.

a. Number Required: One.
b. Mounting: On wall.

6. Supply Fittings:

a. Standard: ASME A112.18.1/CSA B125.1.
b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

1) Operation: Wheel handle.
2) Risers: NPS 1/2, chrome-plated, rigid-copper pipe.

7. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):

1) Size: NPS 2.
2) Material:

a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

C. Kitchen/Utility Sinks - Stainless Steel, Freestanding Three Compartment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. Acorn Engineering Company; www.acorneng.com
    b. American Standard, Inc; www.americanstandard.com
    c. Elkay Manufacturing Company; www.elkay.com
    d. PROFLO; www.ferguson.com
    e. Zurn Industries, LLC; www.zurn.com
2. Source Limitations: Obtain sinks from single source from single manufacturer.
3. Fixture:

    a. Standards:

        1) ASME A112.19.3/CSA B45.4.
        2) NSF 2.

    b. Type: Stainless steel, freestanding, sound-deadened unit with backsplash.
    c. Number of Compartments: One and Three.
    d. Overall Dimensions: 70 by 27 inches.
    e. Material: 14 gauge, Type 304 stainless steel.
    f. Each Compartment:

        1) Dimensions: 24 by 15 inches.
        2) Drains: Grid with NPS 2 tailpiece and twist drain.
        3) Drain Location: Centered in compartment.

    g. Integral Drainboard(s): Left side.

        1) Dimensions: 24 by 24 inches.

4. Legs and Feet: Stainless steel tubing legs with adjustable bullet feet.
5. Faucet(s): Manually Operated Hose Bibb Faucet.

    a. Number Required: One.
    b. Mounting: On wall.

6. Supply Fittings:

    a. Standard: ASME A112.18.1/CSA B125.1.
    b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.

        1) Operation: Wheel handle.
        2) Risers: NPS 1/2, chrome-plated, rigid-copper pipe.

7. Waste Fittings:

    a. Standard: ASME A112.18.2/CSA B125.2.
    b. Trap(s):

        1) Size: NPS 2.
        2) Material:

a) Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.3 MANUALLY OPERATED SINK FAUCETS

A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Kitchen Sink Faucets - Manual Type: Single-control mixing.

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. American Standard, Inc; www.americanstandard.com
    b. Elkay Manufacturing Company; www.elkay.com
    c. PROFLO; www.ferguson.com
    d. Delta; www.deltafaucet.com

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Single hole.
6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Chrome plated.
8. Maximum Flow Rate: 1.8 gpm.
9. Mounting Type: Deck exposed.
10. Valve Handle(s): Lever.
11. Spout Type: Swivel gooseneck.

C. Kitchen Sink Instant Hot Water Faucets - Manual Type: Single-control nonmixing .

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. Insinkerator; www.insinkerator.com

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot-water indicator; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Single hole.

6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Chrome plated.
8. Maximum Flow Rate 0.75 gpm.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): Self Closing Lever.
11. Spout Type: Swivel gooseneck.
12. Spout Outlet: Laminar.

D. Service Sink Faucets - Manual Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. Acorn Engineering Company; www.acorneng.com
    b. American Standard, Inc; www.americanstandard.com
    c. Elkay Manufacturing Company; www.elkay.com
    d. PROFLO; www.ferguson.com
    e. T&S Brass and Bronze Works, Inc;
    f. Zurn Industries, LLC; www.zurn.com
    g. Chicago Faucet; www.chicagofaucets.com

2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
4. Faucet:

    a. Standards:

        1) ASME A112.18.1/CSA B125.1.
        2) NSF 61 and NSF 372.
        3) ICC A117.1.
        4) ASSE 1001 (VB).

    b. Finish: Rough chrome plated.
    c. Handles: 4 arms.
    d. Cartridges: One-fourth turn compression.
    e. Brace: Adjustable top brace.

2.4 SUPPLY FITTINGS

A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.

B. Standard: ASME A112.18.1/CSA B125.1.

C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.

D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

E. Operation: Wheel handle.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.5 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2.
2. Material:

a. Chrome-plated, two-piece, cast-brass trap and swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb in accordance with rough-in drawings.

B. Set floor-mounted sinks in leveling bed of cement grout.

C. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
2. Install stops in locations where they can be easily reached for operation.

D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.

Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

3.6 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 23 - COMMERCIAL SHOWERS

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. Section Includes:

1. Individual showers.
2. Shower heads and shower valves.
3. Shower basins.
4. Grout.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

B. PMMA: Polymethyl methacrylate; also known as "acrylic."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers and basins.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For shower valves to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Shower Valve Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Shower Valve Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Shower valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 INDIVIDUAL SHOWERS

A. Individual, Sectional, FRP ADA Showers without Top:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. American Bath Group; www.americanbathgroup.com
    b. American Standard, Inc; www.americanstandard.com
    c. Aqua Glass Corporation; www.aquaglass.com
    d. Best Bath Systems; www.bestbath.com
    e. Jacuzzi; www.jacuzzi.com
    f. Kohler Company; www.kohler.com
    g. PROFLO; www.ferguson.com

2. Source Limitations: Obtain FRP showers without top from single source from single manufacturer.
3. General: gelcoat FRP shower enclosure with valve and receptor and appurtenances.
4. Standard: CSA B45.5/IAPMO Z124.
5. Style: Handicapped/accessible.
6. Shower Head and Shower Valve: ADA Shower Head and Shower Valve.
7. Shower Nominal Size and Shape: 36 by 36 inches square.
8. Color: White.
9. Outlet: Drain with NPS 2 outlet.
10. Shower Rod and Curtain: Required.
11. Grab Bar: ASTM F446, mounted on support area back wall and shower valve wall.
12. Stopper: T-shaped rubber water stopper.
13. Seat: Folding

2.3 SHOWER HEADS AND SHOWER VALVES

A. ADA Shower Head with Single-Handle, Pressure-Balanced Mixing Valve:.
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. American Standard, Inc; www.americanstandard.com

b. Delta Faucet; www.deltafaucet.com
c. Kohler Company; www.kohler.com
d. PROFLO; www.ferguson.com

2. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
3. Description: Single-handle, accessible, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and hose with handheld shower head on sliding rod.
4. Shower Valve:

a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Mounting: Concealed.
e. Operation: Single-handle, twist or rotate control.
f. Antiscald Device: Not required.
g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

5. Supply Connections: NPS 1/2.
a. EPA WaterSense: Required.
b. Shower Head Maximum Flow Rate: 1.5 gpm.
c. Shower Head Material: Metallic with chrome-plated finish.
d. Spray Pattern: Adjustable.
e. Integral Volume Control: Not required.

B. Shower Head with Single-Handle, Pressure-Balanced Mixing Valve:.
1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

a. American Standard, Inc; www.americanstandard.com
b. Delta Faucet; www.deltafaucet.com
c. Kohler Company; www.kohler.com
d. PROFLO; www.ferguson.com

2. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
3. Description: Single-handle, accessible, pressure-balance mixing valve with hot- and cold-water indicators; and hose with 2 in 1 detachable handheld shower head.
4. Shower Valve:

a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
b. Body Material: Solid brass.
c. Finish: Polished chrome plate.
d. Mounting: Concealed.
e. Operation: Single-handle, twist or rotate control.
f. Antiscald Device: Not required.

5. Supply Connections: NPS 1/2.
a. EPA WaterSense: Required.

b. Shower Head Maximum Flow Rate: 1.75 gpm.
c. Shower Head Material: Metallic with chrome-plated finish.
d. Spray Pattern: Adjustable.
e. Integral Volume Control: Not required.

2.4 SHOWER BASINS

2.5 GROUT

A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000 psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.

B. Examine walls and floors for suitable conditions where showers will be installed.

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

3.2 INSTALLATION

A. Assemble shower components according to manufacturers' written instructions.

B. Install showers level and plumb.

C. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Comply with valve requirements specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping." Install valves in locations that are accessible for ease of operation.

D. Set shower receptors in leveling bed of cement grout.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

F. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 07 92 00 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with traps and soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.

B. Adjust water pressure at shower valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of showers and receptors, inspect and repair damaged finishes.

B. Clean showers and receptors, shower valves, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed fixtures and fittings.

D. Do not allow use of showers and receptors for temporary facilities unless approved in writing by FAA.

END OF SECTION

SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES

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. Section Includes:
   1. Eye/face wash equipment.

1.3 DEFINITIONS

A. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

B. Tepid: Moderately warm.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.

B. Shop Drawings:

   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For emergency plumbing fixtures to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ISEA Standard: Comply with ISEA Z358.1.

B. NSF Standard: Comply with NSF 61 and NSF 372, for fixture materials that will be in contact with potable water.

2.2 EYE/FACE WASH EQUIPMENT

A. Standard, Wall-Mounted, Plumbed Eye/Face Wash Units:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:
   a. Acorn Safety; www.safetymfg.com
   b. Haws Corporation; www.hawsco.com
2. Capacity: Not less than 3.7 gpm for at least 15 minutes.
3. Supply Piping: NPS 1/2 chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
4. Control-Valve Actuator: Paddle .
5. Spray-Head Assembly: Two or four receptor-mounted spray heads.
6. Receptor: ABS Plastic bowl.
7. Drain Piping:

   a. Size: NPS 1-1/2 minimum.
   b. Finish: Chrome-plated brass.
   c. Fittings: Receptor drain, P-trap, waste to wall, and wall flange complying with ASME A112.18.2/CSA B125.2.

8. Mounting: Wall bracket.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.

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

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of the equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. ater Piping."

G. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

H. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

I. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 CONNECTIONS

A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping. Comply with requirements for waste piping specified in Section 221316 "Sanitary Waste and Vent Piping."

C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

SECTION 22 47 13 - DRINKING FOUNTAINS

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. Section Includes:

1. Drinking fountains.
2. Supports.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of drinking fountain and bottle filling station.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include diagrams for power wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For drinking fountains and bottle filling stations to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: No fewer than one each.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Standards:

1. Drinking fountains and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2. rcent.
3. Comply with ASME A112.19.3/CSA B45.4 for stainless steel drinking fountains and bottle filling stations.
4. Comply with NSF 42 and NSF 53 for water filters for drinking fountains and bottle filling stations.
5. Comply with ICC A117.1 for accessible drinking fountains and bottle filling stations.

2.2 DRINKING FOUNTAINS

A. Drinking Fountains - Split Level Surface Wall-Mounted, Vinyl-Covered Metal with Stainless Steel Top:.:

1. Manufacturers: Subject to compliance with requirements, available manufacturers that may be incorporated into the Work include, but are not limited to, the following:

    a. Elkay Manufacturing Company; www.elkay.com
    b. b. Haws Corporation; www.hawsco.com
    c. c. Murdock Manufacturing, Inc; www.murdockmfg.com
    d. d. Oasis International; www.oasiscoolers.com

2. Source Limitations: Obtain surface wall-mounted, vinyl-covered metal with stainless steel top, pressure water coolers from single source from single manufacturer.
3. Type: Split Level

4. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.

5. Bottle Filler: Sensor activation: Fill rate 0.5 to 1.5 gpm. Visual Ticker for number of 20 oz plastic bottles saved from waste.
6. Drain: Grid with NPS 1-1/4 tailpiece.Supply: NPS 3/8 with shutoff valve.
7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/2 chrome-plated brass P-trap and waste.
8. Filter: One or more water filters with capacity sized for unit peak flow rate. Visual filter monitor.
9. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
10. Electrical Characteristics:

    a. Volts: 120 V ac.
    b. Phase: Single.
    c. Hertz: 60 Hz.

11. Support: Provide manufacturer's mounting plate and [drinking fountain carrier.

12. Drinking Fountain Mounting Height: High/low - standard/accessible in accordance with ICC A117.1.

2.3 SUPPORTS

A. Drinking Fountain Carrier:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Elkay Manufacturing Company; www.elkay.com
   b. Zurn Industries, LLC; www.zurn.com
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523.12 "Ball Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for drinking fountain. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."

D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplates to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water-cooler temperature settings.

3.6 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 -- GENERAL

1.1 THE SUMAMRY

A. Section includes:

1) Sleeves

2) Sleeve-seal systems.

3) Grout.

4) Silicone sealants.

1.2 RELATED DOCUMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONS SUBMITTALS

A. Field quality-control reports.

PART 2 -- PRODUCTS

2.1 SLEEVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

1) Advance Products & System, Inc.

2) CALPICO, Inc.

3) GPT; an EnPro industries company.

B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

C. C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following

1) Advance Products & System, Inc.

2) CALPICO, Inc.

3) GPT; an EnPro industries company.

B. Description

1) Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

2) Designed to form a hydrostatic seal of 20-psig minimum.

3) Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.

4) Pressure Plates: Carbon steel.

5) Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi , 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.

b. Sherman-Williams Company.

c. The Dow Company.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited the following:

a. May National Associates, Inc.

PART 3 -- EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1) Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, and concrete walls as new slabs and walls are constructed.

1) Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

2) Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1) Cut sleeves to length for mounting flush with both surfaces.

2) Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

3) Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 - Penetration Firestopping.

3.2 SLEEVE SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1) Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1) Exterior Concrete Walls Below Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2) Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3) Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.

END OF SECTION

SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section includes:

1) Escutcheons

2) Floor plates

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

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

1) BrassCraft Manufacturing Co.; a Masco company.

2) Keeney Manufacturing Company (The).

3) Mid-America Fittings, LLC; A Midland Industries Company.

2.2 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

D. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed rivet hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1) Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.

b. Chrome-Plated Piping: One-piece cast brass or split-plate steel with polished, chrome-plated finish.

c. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

f. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

g. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1) New Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1) Metal pipe hangers and supports.

2) Trapeze pipe hangers.

3) Thermal-hanger shield inserts.

4) Fastener systems.

5) Outdoor Equipment Stands.

1.2 RELATED DOCUMENTS

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

1.3 RELATED REQUIREMENTS

A. Section 05 50 00 - Miscellaneous Metalwork

1) For structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

B. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping, for pipe guides and anchors.

C. Section 23 05 48 - Vibration and Seismic Controls for HVAC, for vibration isolation devices.

D. Section 23 31 13 - Metal Ducts, for duct hangers and supports.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:

1) Trapeze pipe hangers.

2) Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1) Detail fabrication and assembly of trapeze hangers.

2) Include design calculations for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

A. Welding Certificates

1.6 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1) Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2) Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

3) Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1) Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2) Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.

3) Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.

4) Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5) Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless Steel Pipe Hangers and Supports:

1) Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2) Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3) Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1) Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.

2) Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL-HANGER SHIELD INSERTS

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

1) National Pipe Hanger Corporation.

2) Pipe Shields Inc.

3) Piping Technology & Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi (688-kPa)] or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi (862-kPa) minimum compressive strength and vapor barrier.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1) Indoor Applications: stainless steel.

2) Outdoor Applications: Stainless steel.

2.6 OUTDOOR EQUIPMENT STANDS

A. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components, without roof membrane penetration, in a pre-fabricated system that can be modularly-assembled on site.

B. Foot Material: Rubber or polypropylene.

C. Rails Material: Hot dip galvanized carbon steel.

D. Wind/Sliding Load Resistance: Up to 100 mph minimum.

2.7 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1) Properties: Nonstaining, noncorrosive, and nongaseous.

2) Design Mix: 5000-psi, 28-day compressive strength.

PART 3 -- EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb .

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1) Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2) Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

D. Fastener System Installation:

1) Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2) Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1) Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2) Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3) Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

4) Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2 : 12 inches long and 0.048 inch thick.

5) Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1) Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2) Obtain fusion without undercut or overlap.

3) Remove welding flux immediately.

4) Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Comply with requirements in Section 09 91 13 - Exterior Painting or Section 09 91 23 - Interior Painting, for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use stainless steel pipe hangers and stainless steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 .

2) Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.

3) Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

4) Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 , to allow off-center closure for hanger installation before pipe erection.

5) Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

6) Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 .

7) Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8) Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9) Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

10) Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 .

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2) Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

2) Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

3) Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

4) Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

2) Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

3) Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

4) Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

5) C-Clamps (MSS Type 23): For structural shapes.

6) Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

7) Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

8) Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

9) Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

10) Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

11) Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1) Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2) Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3) Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

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SECTION 23 05 48 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1) Elastomeric isolation pads.

2) Elastomeric isolation mounts.

3) Housed-spring isolators.

4) Housed-restrained-spring isolators.

5) Pipe-riser resilient support.

6) Resilient pipe guides.

7) Elastomeric hangers.

8) Spring hangers.

9) Snubbers.

10) Restraints - rigid type.

11) Restraints - cable type.

12) Restraint accessories.

13) Post-installed concrete anchors.

14) Concrete inserts.

B. Related Requirements:

1) Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1) Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2) Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component.

3) Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing, UL product listing or FM Approvals. Annotate to indicate application of each product submitted and compliance with requirements.

4) Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1) Detail fabrication and assembly of equipment bases

C. Delegated-Design Submittal:

1) For each seismic-restraint device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, concrete anchor and insert, that is required by this Section or is indicated on Drawings, submit the following:

a. SeismicRestraint, and Vibration Isolation Base Selection: Select vibration isolators, seismic-restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.

b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.

c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

d. Seismic Design Calculations: Submit all input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.

2) Seismic- and Wind-Restraint Detail Drawing:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3) All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

4) Product Listing, Preapproval, and Evaluation Documentation: By an evaluation service member of ICC-ES, UL, or FM Approvals, showing maximum ratings of restraint items and basis for approval (tests or calculations).

5) Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.

6) Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer.

C. Welding certificates.

D. Field quality-control reports.

E. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1) Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 , including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction or ASCE/SEI 7-16.

2) Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-16.

3) Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing, UL product listing, FM Approvals.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 - Quality Requirements, to design seismic load control system.

1) Seismic Performance: Equipment shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7-16.

B. Seismic Design Calculations:

1) Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-16. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the Section Text.

a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.

b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

c. Building Occupancy Category: II.

d. Building Risk Category: II.

e. Building Site Classification: D.

2) Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

   a. Horizontal Seismic Design Force Fp: Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation:

      1) SDS = Spectral Acceleration: 0.818. Value applies to all components on Project.

      2) ap = Component Amplification Factor: Determine for each component by Delegated-Design Contractor.

      3) Ip = Component Importance Factor: Determine for each component by Delegated-Design Contractor.

      4) Wp = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.

      5) Rp = Component Response Modification Factor: Determine for each component by Delegated-Design Contractor.

      6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.

      7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.

   b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.

   c. Seismic Relative Displacement Dpl: Calculate by Delegated-Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:

      1) Dp = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated-Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.

      2) Ie = Structure Importance Factor: 1.0. Value applies to all components on Project.

      3) δxA = Deflection at Building Level x of Structure A: Determine for each component by Delegated-Design Contractor.

      4) δyA = Deflection at Building Level y of Structure A: Determine for each component by Delegated-Design Contractor.

5) δyB = Deflection at Building Level y of Structure B: Determine for each component by Delegated-Design Contractor.

6) hx = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.

7) hy = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.

8) ΔaA = Allowable Story Drift for Structure A: Determine for each component by Delegated-Design Contractor.

9) ΔaB = Allowable Story Drift for Structure B: Determine for each component by Delegated-Design Contractor.

10) hsx = Story Height Used in the Definition of Allowable Drift Δa: Determine for each component by Delegated-Design Contractor.

d. Component Fundamental Period Tp: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:

1) Wp = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.

2) g = Gravitational Acceleration: 32.17 fps2 .

3) Kp = Combined Stiffness of Component, Supports, and Attachments: Determined by delegated-design seismic engineer..

C. Consequential Damage: Provide additional seismic restraints for suspended HVAC components or anchorage of floor-, roof-, or wall-mounted HVAC components as indicated in ASCE/SEI 7-16 so that failure of a non-essential or essential HVAC component will not cause failure of any other essential architectural, mechanical, or electrical building component.

D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1) Load ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.

2) All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-16 Section 13.6.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

3) Size: Factory or field cut to match requirements of supported equipment.

4) Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.

5) Surface Pattern: Smooth, ribbed, or waffle pattern.

6) Infused nonwoven cotton or synthetic fibers.

7) Load-bearing metal plates adhered to pads.

8) Sandwich-Core Material: Resilient and elastomeric.

a. Surface Pattern: Smooth, ribbed, or waffle pattern.

b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.

b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3) 3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material/

2.4 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3) Minimum Additional Travel: 50 percent of the required deflection at rated load.

4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6) Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

b. Top housing with attachment and leveling bolt.

2.5 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.

b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4) Minimum Additional Travel: 50 percent of the required deflection at rated load.

5) Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.6 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. Vibration Management Corp.

2) Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.

3) Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.7 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- Thick Neoprene:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsert -able to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.8 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

3) Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.9 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.

c. VMC GROUP.

2) Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

3) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4) Minimum Additional Travel: 50 percent of the required deflection at rated load.

5) Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

7) Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

8) Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

9) Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.10 SNUBBERS

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

1) Kinetics Noise Control, Inc.

2) Mason Industries, Inc.

3) VMC GROUP.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1) Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-14 Ch. 17 for 2018 IBC.

2) Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.

3) Anchors in Masonry: Design in accordance with TMS 402.

4) Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

5) Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

2.11 RESTRAINTS - RIGID TYPE

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

1) Eaton (B-Line)

2) Hilti, Inc.

3) TOLCO Incorporated.

B. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.12 RESTRAINTS - CABLE TYPE

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

1) Eaton (B-Line)

2) Loos & Co. Inc.

3) VMC GROUP.

B. Seismic-Restraint Cables: ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.13 RESTRAINT ACCESSORIES

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

1) Eaton (B-Line)

2) Hilti, Inc.

3) TOLCO Incorporated.

B. Hanger-Rod Stiffener: Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.14 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (B-Line).

b. Hilti, Inc.

c. Powers Fasteners.

2) Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Eaton (B-Line).

b. Hilti, Inc.

c. Powers Fasteners.

2) Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in wind-load applications. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-16, Ch. 13.

1) Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

2) Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

2.15 CONCRETE INSERTS

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

1) Eaton (B-Line).

2) Hilti, Inc.

3) Powers Fasteners.

B. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS SP-58.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

D. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1) Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2) Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch .

3) Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Piping Restraints:

1) Comply with requirements in MSS SP-127.

2) Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3) Brace a change of direction longer than 12 feet .

H. Install seismic-restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Mechanical Anchor Bolts:

1) Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2) Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3) Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4) Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5) Set anchors to manufacturer's recommended torque, using a torque wrench.

6) Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 23 21 13 - Hydronic Piping and Section 23 21 16 - Hydronic Piping Specialties, for piping flexible connections.

3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections

1) Perform tests and inspections.

2) Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

3) Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.

4) Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

5) Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.

6) Test to 90 percent of rated proof load of device.

7) Measure isolator restraint clearance.

8) Measure isolator deflection.

9) Verify snubber minimum clearances.

C. Remove and replace malfunctioning units and retest as specified above.

D. Units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

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SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1) Equipment labels.

2) Warning signs and labels.

3) Pipe labels.

4) Duct labels.

5) Stencils.

6) Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 -- PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Brimar Industries, Inc.

c. Seton Identification Products; a Brady Corporation company.

2) Material and Thickness: Brass, 0.032-inch or aluminum, 0.032-inch minimum thickness, with predrilled or stamped holes for attachment hardware.

3) Letter and Background Color: As indicated for specific application under Part 3.

4) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .

5) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances of up to 72 inches , and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

6) Fasteners: Stainless steel rivets or self-tapping screws.

7) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.

b. Brimar Inductries, Inc.

c. Seton Identification Products; a Brady Corporation company.

2) Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.

3) Letter and Background Color: As indicated for specific application under Part 3.

4) Maximum Temperature: Able to withstand temperatures of up to 160 deg F .

5) Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .

6) Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches , 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7) Fasteners: Stainless steel rivets or self-tapping screws.

8) Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1) Brady Corporation.

2) Carlton Industries, LP.

3) Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-taping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

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

1) Brady Corporation.

2) Carlton Industries, LP.

3) Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:

1) Pipe size.

2) Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.

3) Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

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

1) Brady Corporation.

2) Brimar Industries, Inc.

3) Seton Identification Products; a Brady Corporation company.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F .

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch .

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings. Also include the following:

1) Duct size.

2) Flow-Direction Arrows: Include flow-direction arrows on main distribution ducts. Arrows may be either integral with label or may be applied separately.

3) Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.5 STENCILS

A. Stencils for Ducts:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Craftmark Pipe Markers.

b. Kolbi Pipe Marker Co.

c. Pipemarker.com; Brimar Industries, Inc.

2) Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances of up to 15 ft. and proportionately larger lettering for greater viewing distances.

3) Stencil Material: Flexible polyester or metal.

4) Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.

5) Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

6) Letter and Background Color: Color as indicated for specific application under Part 3.

B. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Craftmark Pipe Markers.

b. Kolbi Pipe Marker Co.

c. Pipemarker.com; Brimar Industries, Inc.

2) Lettering Size: Minimum letter height of 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

3) Stencil Material: Flexible polyester or metal.

4) Stencil Paint: Exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.

5) Identification Paint: Exterior, acrylic enamel. Paint may be in pressurized spray-can form.

6) Letter and Background Color: As indicated for specific application under Part 3.

2.6 VALVE TAGS

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

1) Brady Corporation.

2) Seton Identification Products; a Brady Corporation company.

3) emedco.

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1) Tag Material: Brass, 0.04-inch or anodized aluminum, 0.031-inch minimum thickness, with predrilled or stamped holes for attachment hardware.

2) Fasteners: Brass link chain or beaded chain.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1) Include valve-tag schedule in operation and maintenance data.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS

A. Permanently fasten labels on each item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1) Within 3 ft. of each valve and control device.

2) At access doors, manholes, and similar access points that permit view of concealed piping.

3) Within 3 ft. of equipment items and other points of origination and termination.

4) Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.

C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe-Label Color Schedule:

1) Refrigerant Piping: White letters on an ANSI Z535.1 safety-blue background.

3.5 INSTALLATION OF DUCT LABELS

A. Install plastic-laminated self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.

1) Provide labels in the following color codes:

a. For air supply ducts: White letters on blue background.

b. For air return ducts: White letters on blue background.

c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.

B. Stenciled Duct-Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

1) For all air ducts: Black letters on white background.

C. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. where exposed or are concealed by removable ceiling system.

D. Stenciled Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1) Black letters on White background.

3.6 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.

1) Valve-Tag Size and Shape:

a. Refrigerant: 1-1/2 inches , round.

2) Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1) Testing, Adjusting, and Balancing of Air Systems:

a. Constant-volume air systems.

2) Testing, adjusting, and balancing of equipment.

3) Testing, adjusting, and balancing of existing HVAC systems and equipment.

4) Sound tests.

5) Vibration tests.

6) Duct leakage tests verification.

7) Pipe leakage tests verification.

8) HVAC-control system verification.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

1.4 INFORMATIONAL SUBMITTALS

A. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

B. Certified TAB reports.

C. Sample report forms.

D. Instrument calibration reports, to include the following:

1) Instrument type and make.

2) Serial number.

3) Application.

4) Dates of use.

5) Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications, Certified by NEBB:

1) TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.

2) TAB Technician: Employee of the TAB specialist and certified by NEBB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

D. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Full Owner Occupancy: OWNER will occupy the site and existing building during entire TAB period. Cooperate with OWNER during TAB operations to minimize conflicts with OWNER's operations.

B. Partial Owner Occupancy: OWNER may occupy completed areas of building before Substantial Completion. Cooperate with OWNER during TAB operations to minimize conflicts with OWNER's operations.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data, including fan and pump curves.

1) Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainer baskets are installed and clean.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine operating safety interlocks and controls on HVAC equipment.

L. Examine control dampers for proper installation for their intended function of isolating, throttling, diverting, or mixing air flows.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1) Equipment and systems to be tested.

2) Strategies and step-by-step procedures for balancing the systems.

3) Instrumentation to be used.

4) Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1) Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.

b. Duct systems are complete with terminals installed.

c. Volume, smoke, and fire dampers are open and functional.

d. Clean filters are installed.

e. Fans are operating, free of vibration, and rotating in correct direction.

f. Variable-frequency controllers' startup is complete and safeties are verified.

g. Automatic temperature-control systems are operational.

h. Ceilings are installed.

i. Windows and doors are installed.

j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system in accordance with the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment casings for installation of test probes to the minimum extent necessary for TAB procedures.

1) After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 - Air Duct Accessories.

2) Where holes for probes are required in piping or hydronic equipment, install pressure and temperature test plugs to seal systems.

3) Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish in accordance with Section 23 07 13 - Duct Insulation, Section 23 07 16 - HVAC Equipment Insulation, and Section 23 07 19 - HVAC Piping Insulation.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 TESTING, ADJUSTING, AND BALANCING OF HVAC EQUIPMENT

A. Test, adjust, and balance HVAC equipment indicated on Drawings, including, but not limited to, the following:

1) Motors.

2) Fans and ventilators.

3) Radiant heaters.

4) Unit heaters.

5) Dedicated outdoor-air units.

6) Variable-refrigerant-flow systems.

7) Heat pumps.

8) Coils.

9) Finned-tube radiation heaters.

10) Radiant-heating panels.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' Record drawings duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1) Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses close to the fan and prior to any outlets, to obtain total airflow.

c. Where duct conditions are unsuitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2) Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.

b. Measure static pressure directly at the fan inlet or through the flexible connection.

c. Measure static pressure across each component that makes up the air-handling system.

d. Report artificial loading of filters at the time static pressures are measured.

3) Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1) Measure airflow of submain and branch ducts.

2) Adjust submain and branch duct volume dampers for specified airflow.

3) Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1) Set airflow patterns of adjustable outlets for proper distribution without drafts.

2) Measure inlets and outlets airflow.

3) Adjust each inlet and outlet for specified airflow.

4) Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1) Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.

2) Re-measure and confirm that total airflow is within design.

3) Re-measure all final fan operating data, speed, volts, amps, and static profile.

4) Mark all final settings.

5) Test system in economizer mode. Verify proper operation and adjust if necessary.

6) Measure and record all operating data.

7) Record final fan-performance data.

3.7 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1) Manufacturer's name, model number, and serial number.

2) Motor horsepower rating.

3) Motor rpm.

4) Phase and hertz.

5) Nameplate and measured voltage, each phase.

6) Nameplate and measured amperage, each phase.

7) Starter size and thermal-protection-element rating.

8) Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

C. Kitchen Hoods:

1) Measure and record airflow by duct traverse.

2) Capture and Containment: Check each hood for proper capture and containment using a smoke-emitting device. Observe and report performance. Make adjustments to achieve optimum results.

3.8 DUCT LEAKAGE TESTS

A. Witness the duct leakage testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.9 PIPE LEAKAGE TESTS

A. Witness the pipe pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified limits.

C. Report deficiencies observed.

3.10 HVAC CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1) Verify HVAC control system is operating within the design limitations.

2) Confirm that the sequences of operation are in compliance with Contract Documents.

3) Verify that controllers are calibrated and function as intended.

4) Verify that controller set points are as indicated.

5) Verify the operation of lockout or interlock systems.

6) Verify the operation of valve and damper actuators.

7) Verify that controlled devices are properly installed and connected to correct controller.

8) Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.

9) Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.11 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1) Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent. If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).

2) Air Outlets and Inlets: Plus or minus 10 percent. If design value is less than 100 cfm (47 L/s), within 10 cfm (4.7 L/s).

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.12 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1) Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.

2) Include a list of instruments used for procedures, along with proof of calibration.

3) Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1) Pump curves.

2) Fan curves.

3) Manufacturers' test data.

4) Field test reports prepared by system and equipment installers.

5) Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1) Title page.

2) Name and address of the TAB specialist.

3) Project name.

4) Project location.

5) Architect's name and address.

6) Engineer's name and address.

7) Contractor's name and address.

8) Report date.

9) Signature of TAB supervisor who certifies the report.

10) Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

11) Summary of contents, including the following:

a. Indicated versus final performance.

b. Notable characteristics of systems.

c. Description of system operation sequence if it varies from the Contract Documents.

12) Nomenclature sheets for each item of equipment.

13) Data for terminal units, including manufacturer's name, type, size, and fittings.

14) Notes to explain why certain final data in the body of reports vary from indicated values.

15) Test conditions for fans performance forms, including the following:

a. Settings for outdoor-, return-, and exhaust-air dampers.

b. Conditions of filters.

c. Settings for pressure controller(s).

d. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1) Quantities of outdoor, supply, return, and exhaust airflows.

2) Duct, outlet, and inlet sizes.

3) Position of balancing devices.

E. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1) Fan Data:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

2) Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and speed.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

3) Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm .

b. Total system static pressure in inches wg .

c. Fan speed.

d. Discharge static pressure in inches wg .

e. Suction static pressure in inches wg .

F. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1) Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

G. Instrument Calibration Reports:

1) Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.13 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

B. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to the lesser of either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the TAB shall be considered incomplete and shall be rejected.

E. If recheck measurements find the number of failed measurements noncompliant with requirements indicated, proceed as follows:

1) TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection. All changes shall be tracked to show changes made to previous report.

2) If the second final inspection also fails, OWNER may pursue others Contract options to complete TAB work.

F. Prepare test and inspection reports.

3.14 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 13 - DUCT INSULATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section includes insulating the following duct services:

1) Indoor, concealed supply and outdoor air.

2) Indoor, exposed supply and outdoor air.

3) Indoor, concealed exhaust between isolation damper and penetration of building exterior.

4) Indoor, exposed exhaust between isolation damper and penetration of building exterior.

B. Related Sections:

1) Section 23 07 19 - HVAC Piping Insulation

2) Section 23 31 13 - Metal Ducts for duct liners.

1.2 RELATED DOCUMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1) Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

PART 2 -- PRODCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type II for sheet materials.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA.

b. Armacell LLC.

c. K-Flex USA.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Insulation,

b. Johns Manville

c. Owens Corning

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Insulation,

b. Johns Manville

c. Owens Corning

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Insulation,

b. Johns Manville

c. Owens Corning

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller.

c. Mon-Eco Industries, Inc.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller.

c. Mon-Eco Industries, Inc.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dow Consumer Solutions.

b. Johns Manville; a Berkshire Hathaway company.

c. Speedline Corporation.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Water based; suitable for indoor use on below ambient services.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Knauf Insulation.

c. Vimasco Corporation.

2) Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.

3) Service Temperature Range: Minus 20 to plus 180 deg F .

4) Comply with MIL-PRF-19565C, Type II, for permeance requirements.

5) Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Knauf Insulation.

b. Mon-Eco Industries, Inc.

c. Vimasco Corporation.

2) Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.

3) Service Temperature Range: Minus 20 to plus 180 deg F.

4) Color: White.

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller.

c. Mon-Eco Industries, Inc.

2) Materials shall be compatible with insulation materials, jackets, and substrates.

3) Fire- and water-resistant, flexible, elastomeric sealant.

4) Service Temperature Range: Minus 40 to plus 250 deg F.

5) Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

2) Materials shall be compatible with insulation materials, jackets, and substrates.

3) Fire- and water-resistant, flexible, elastomeric sealant.

4) Service Temperature Range: Minus 40 to plus 250 deg F.

5) Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1) ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2) ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

3) FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

4) FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

5) Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. , in a Leno weave, for ducts.

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.

b. P.I.C. Plastics, Inc.

c. Speedline Corporation.

2) Adhesive: As recommended by jacket material manufacturer.

3) Color: White.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division.

b. Ideal Tape Co., Inc., an American Biltrite Company.

c. Knauf Insulation.

2) Width: 3 inches.

3) Thickness: 11.5 mils .

4) Adhesion: 90 ounces force/inch in width.

5) Elongation: 2 percent.

6) Tensile Strength: 40 lbf/inch in width.

7) ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division.

b. Ideal Tape Co., Inc., an American Biltrite Company.

c. Knauf Insulation.

2) Width: 3 inches.

3) Thickness: 11.5 mils .

4) Adhesion: 90 ounces force/inch in width.

5) Elongation: 2 percent.

6) Tensile Strength: 40 lbf/inch in width.

7) ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Compac Corporation.

b. Ideal Tape Co., Inc., an American Biltrite Company.

c. Venture Tape.

2) Width: 2 inches .

3) Thickness: 6 mils .

4) Adhesion: 64 ounces force/inch in width.

5) Elongation: 500 percent.

6) Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. ITW Insulation systems; Illinois Tool Works, Inc.

b. RPR Products, Inc.

2) Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.

3) Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal or closed seal.

4) Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1) Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Hardcast, a Carlisle Company.

2) Midwest Fasteners, Inc.

3) Nelson Stud Welding.

2) Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gemco.

2) Hardcast; a Carlisle Company.

3) Midwest Fasteners, Inc.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

3) Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gemco.

2) Midwest Fasteners, Inc.

3) Nelson Stud Welding.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. C & F Wire Products.

2.11 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch , PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch , aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1) Verify that systems to be insulated have been tested and are free of defects.

2) Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1) Install insulation continuously through hangers and around anchor attachments.

2) For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3) Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1) Draw jacket tight and smooth.

2) Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3) Overlap jacket longitudinal seams at least 1-1/2 inches . Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4) Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5) Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1) Seal penetrations with flashing sealant.

2) For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3) Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4) Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1) Seal penetrations with flashing sealant.

2) For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3) Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches .

4) Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches .

1) Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1) Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2) Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3) Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

b. On duct sides with dimensions larger than 18 inches , place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

e. Impale insulation over pins and attach speed washers.

f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4) For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches .

5) Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6) Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7) Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1) Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2) Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3) Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.

   b. On duct sides with dimensions larger than 18 inches , space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

   d. Do not overcompress insulation during installation.

e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4) For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches .

5) Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6) Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1) Draw jacket material smooth and tight.

2) Install lap or joint strips with same material as jacket.

3) Secure jacket to insulation with manufacturer's recommended adhesive.

4) Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

5) Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 - Penetration Firestopping.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 - Exterior Painting and Section 09 91 23 - Interior Painting.

1) Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1) Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1) Indoor, concealed supply and outdoor air.

2) Indoor, exposed supply and outdoor air.

3) Indoor, concealed exhaust between isolation damper and penetration of building exterior. And upstream of exhaust damper to exhaust fan unit inlet, but no less than 10 ft.

4) Indoor, exposed exhaust between isolation damper and penetration of building exterior. And upstream of exhaust damper to exhaust fan unit inlet, but no less than 10 ft.

B. Items Not Insulated:

1) Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

2) Factory-insulated flexible ducts.

3) Factory-insulated plenums and casings.

4) Flexible connectors.

5) Vibration-control devices.

6) Factory-insulated access panels and doors.

3.12 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, supply-air duct insulation shall be one of the following:

1) Flexible Elastomeric: 1-1/2 inch thick.

2) Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

B. Concealed, outdoor-air duct insulation shall be one of the following:

1) Flexible Elastomeric: 2 inch thick.

2) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

C. Concealed, exhaust-air duct insulation shall be one of the following:

1) Flexible Elastomeric: 2 inch thick. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

2) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

D. Concealed, supply-air plenum insulation shall be one of the following:

1) Flexible Elastomeric: 1-1/2 inch thick.

2) Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft nominal density.

E. Concealed, outdoor-air plenum insulation shall be one of the following:

1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. (nominal density.

2) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

F. Concealed, exhaust-air plenum insulation shall be one of the following:

1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

2) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

G. Exposed, supply-air duct insulation shall be one of the following:

1) Flexible Elastomeric: 1-1/2 inch thick.

2) Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

H. Exposed, outdoor-air duct insulation shall be one of the following:

1) Flexible Elastomeric: 2 inch thick.

2) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

I. Exposed, exhaust-air duct insulation shall be one of the following:

1) Flexible Elastomeric: 2 inch thick.

2) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

J. Exposed, supply-air plenum insulation shall be one of the following:

1) Flexible Elastomeric: 1-1/2 inch thick.

2) Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

3) Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

K. Exposed, outdoor-air plenum insulation shall be one of the following:

1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

2) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

L. Exposed, exhaust-air plenum insulation shall be one of the following:

1) Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

2) Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1) None.

D. Ducts and Plenums, Exposed:

1) PVC: 20 mils (0.5 mm) thick.

END OF SECTION

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SECTION 23 07 19 - HVAC PIPING INSULATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section includes insulation for HVAC piping systems.

B. Related Requirements:

1) Section 23 07 13 - Duct Insulation

1.2 RELATED DOCUMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1) Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2) Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

3) Detail removable insulation at piping specialties.

4) Detail application of field-applied jackets.

5) Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1) Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2) Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 -- PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and "Outdoor, Aboveground Piping Insulation Schedule," articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.

b. Armacell LLC.

c. K-Flex USA.

G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.

b. Knauf Insulation.

c. Owens Corning.

2) Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.

3) 850 deg F .

4) Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.

5) Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.

b. Armacell LLC.

c. K-Flex USA.

2) Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.

3) Wet Flash Point: Below 0 deg F .

4) Service Temperature Range: 40 to 200 deg F .

5) Color: Black.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.

D. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. P.I.C. Plastics, Inc.

b. Speedline Corporation.

c. The Dow Chemical Company.

2.3 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller.

c. Knauf Insulation.

2) Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.

3) Service Temperature Range: 0 to plus 180 deg F.

4) Color:White.

2.4 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Vimasco Corporation.

2) Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.

3) Service Temperature Range: 0 to plus 180 deg F.

4) Color: White.

2.5 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.

2) Permanently flexible, elastomeric sealant.

a. Service Temperature Range: Minus 150 to plus 250 deg F .

b. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.

2) Fire- and water-resistant, flexible, elastomeric sealant.

3) Service Temperature Range: Minus 40 to plus 250 deg F .

4) Color: Aluminum.

D. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.

b. Foster Brand; H. B. Fuller Construction Products.

c. Fire- and water-resistant, flexible, elastomeric sealant.

2) Service Temperature Range: Minus 40 to plus 250 deg F .

3) Color: White.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1) ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2) ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

3) FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.7 FIELD-APPLIED REINFORCING MESH

A. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. , in a Leno weave, for pipe.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2) Childers Brand; H. B. Fuller Construction Products.

3) Foster Brand; H. B. Fuller Construction Products.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. .

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Alpha Associates, Inc.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.

b. P.I.C. Plastics, Inc.

c. Speedline Corporation.

2) Adhesive: As recommended by jacket material manufacturer.

3) Color: White.

4) Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.

b. RPR Products, Inc.

2) Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper 2.5-mil- thick polysurlyn.

d. Moisture Barrier for Outdoor Applications: 2.5-mil- thick polysurlyn.

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2) MFM Building Products Corp.

3) Polyguard Products, Inc.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.

b. Avery Dennison Corporation, Specialty Tapes Division.

c. Knauf Insulation.

2) Width: 3 inches.

3) Thickness: 11.5 mils.

4) Adhesion: 90 ounces force/inch in width.

5) Elongation: 2 percent.

6) Tensile Strength: 40 lbf/inch in width.

7) ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.

b. Avery Dennison Corporation, Specialty Tapes Division.

c. Knauf Insulation.

2) Width: 3 inches .

3) Thickness: 6.5 mils .

4) Adhesion: 90 ounces force/inch in width.

5) Elongation: 2 percent.

6) Tensile Strength: 40 lbf/inch in width.

7) FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.

b. Ideal Tape Co., Inc., an American Biltrite Company.

2) Width: 2 inches .

3) Thickness: 6 mils .

4) Adhesion: 64 ounces force/inch in width.

5) Elongation: 500 percent.

6) Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.

b. Avery Dennison Corporation, Specialty Tapes Division.

c. Ideal Tape Co., Inc., an American Biltrite Company.

2) Width: 2 inches.

3) Thickness: 3.7 mils.

4) Adhesion: 100 ounces force/inch in width.

5) Elongation: 5 percent.

6) Tensile Strength: 34 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.

b. RPR Products, Inc.

2) Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.Aluminum: ASTM B209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.

3) Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1) Manufacturers: Subject to compliance with requirements, provide products by the following:

a. C & F Wire.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1) Verify that systems to be insulated have been tested and are free of defects.

2) Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1) Install insulation continuously through hangers and around anchor attachments.

2) For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.

3) Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4) Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1) Draw jacket tight and smooth.

2) Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.

3) Overlap jacket longitudinal seams at least 1-1/2 inches . Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4) Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

5) Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1) Vibration-control devices.

2) Testing agency labels and stamps.

3) Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1) Seal penetrations with flashing sealant.

2) For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3) Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4) Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1) Seal penetrations with flashing sealant.

2) For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3) Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches .

4) Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1) Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1) Pipe: Install insulation continuously through floor penetrations.

2) Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 - Penetration Firestopping.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1) Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2) Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3) Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4) Insulate valves using preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5) Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.

6) Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

7) For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers. Installation shall conform to the following:

1) Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.

2) When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

3) Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

4) When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5) Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1) Insulation Installation on Pipe Flanges:

2) Install pipe insulation to outer diameter of pipe flange.

3) Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

4) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.

5) Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1) Install mitered sections of pipe insulation.

2) Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1) Install preformed valve covers manufactured of same material as that of pipe insulation when available.

2) When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3) Install insulation to flanges as specified for flange insulation application.

4) Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1) Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

2) Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3) For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

4) For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1) Install preformed pipe insulation to outer diameter of pipe flange.

2) Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4) Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1) Install preformed sections of same material as that of straight segments of pipe insulation when available.

2) When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1) Install preformed sections of same material as that of straight segments of pipe insulation when available.

2) When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3) Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4) Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF FIELD-APPLIED JACKETS

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1) Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

2) Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3) Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1) Draw jacket material smooth and tight.

2) Install lap or joint strips with same material as jacket.

3) Secure jacket to insulation with manufacturer's recommended adhesive.

4) Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

5) Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated and for horizontal applications, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1) Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1) Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.10 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, three locations of threaded valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1) All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick.

b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Refrigerant Suction and Hot-Gas Piping:

1) All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

1) All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

D. Refrigerant Liquid Piping:

1) All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1inch thick.

3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:

1) All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inches thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:

1) All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inches thick.

C. Refrigerant Liquid Piping:

1) All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

3.14 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1) None.

D. Piping, Exposed:

1) PVC: 20 mils thick.

3.15 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed:

1) None.

3.16 Piping, Exposed:

1) Painted Aluminum, Stucco Embossed: 0.032 inch thick.

END OF SECTION

SECTION 23 09 23.12 - CONTROL DAMPERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1) Rectangular control dampers.
2) Round control dampers.
3) Electric and electronic control damper actuators.

B. Related Requirements:
1) Section 23 09 93 - Sequence of Operations for HVAC Controls, for requirements that relate to Section 23 09 23.12.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of damper and actuator:

1) Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2) Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3) Product description with complete technical data, performance curves, and product specification sheets.
4) Installation instructions, including factors affecting performance.

B. Shop Drawings:
1) Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2) Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. rresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1) Product installation location shown in relationship to room, duct, and equipment.

2) Size and location of wall access panels for control dampers and actuators installed behind walls.
3) Size and location of ceiling access panels for control dampers and actuators installed above inaccessible ceilings.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control dampers to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

D. Backup Power Source: Systems and equipment served by a backup power source shall have associated control damper actuators served from a backup power source.

E. Selection Criteria:

1) Control dampers shall be suitable for operation at following conditions:

a. Supply Air: 3” WC pressure and coincident temperature 150 deg F.
b. Return Air: 3” WC pressure and coincident temperature 150 deg F.
c. Outdoor Air: 3” WC pressure and coincident temperature 0 deg F.
d. Mixed Air: 3” WC pressure and coincident temperature 0 deg F.
e. Exhaust Air: 2” WC pressure and coincident temperature 120 deg F.
f. .

2) Fail positions unless otherwise indicated:

a. Supply Air: Open.
b. Return Air: Open.
c. Outdoor Air: Close.
d. Mixed Air: Open.
e. Exhaust Air: Close.
f. .

3) Dampers shall have stable operation throughout full range of operation, from design to minimum airflow over varying pressures and temperatures encountered.

4) Select modulating dampers for a pressure drop of 2 percent of fan total static pressure unless otherwise indicated.
5) Two-position dampers shall be full size of duct or equipment connection unless otherwise indicated.

2.2 RECTANGULAR CONTROL DAMPERS

A. General Requirements:

1) Unless otherwise indicated, use parallel blade configuration for two-position control, equipment isolation service, and when mixing two airstreams. For other applications, use opposed blade configuration.
2) Factory assemble multiple damper sections to provide a single damper assembly of size required by the application.

B. Rectangular Dampers with Aluminum Airfoil Blades:
1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Greenheck,
b. Ruskin

2)
3) Performance:

a. Leakage: AMCA 511, Class 1A. Leakage shall not exceed 3 cfm/sq. ft. against 1-in. wg differential static pressure.
b. Pressure Drop: 0.05-in. wg at 1500 fpm across a 24-by-24-inch damper when tested according to AMCA 500-D, figure 5.3.
c. Velocity: Up to 6000 fpm .
d. Temperature: Minus 40 to plus 185 deg F .
e. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
f. Damper shall have AMCA seal for both air leakage and air performance.

4) Construction:

a. Frame:

1) Material: ASTM B211, Alloy 6063 T5 extruded-aluminum profiles, 0.07 inch thick.
2) Hat-shaped channel with integral flange(s). Mating face shall be a minimum of 1 inch .
3) Width not less than 5 inches .

b. Blades:

1) Hollow, airfoil, extruded aluminum.
2) Parallel or opposed blade configuration as required by application.
3) Material: ASTM B211, Alloy 6063 T5 aluminum, 0.07 inch thick.
4) Width not to exceed 6 inches .

5) Length as required by close-off pressure, not to exceed 48 inches .

c. Seals:

1) Blades: Replaceable, mechanically attached extruded silicone, vinyl, or plastic composite.
2) Jambs: Stainless steel, compression type.

d. Axles: 0.5-inch- diameter stainless steel, mechanically attached to blades.
e. Bearings:

1) Molded synthetic or stainless steel sleeve mounted in frame.
2) Where blade axles are installed in vertical position, provide thrust bearings.

f. Linkage:

1) Concealed in frame.
2) Constructed of aluminum and stainless steel.
3) Hardware: Stainless steel.

g. Transition:

1) For round and flat oval duct applications, provide damper assembly with integral transitions to mate to adjoining field connection.
2) Factory mount damper in a sleeve with a close transition to mate to field connection.
3) Damper size and sleeve shall be connection size plus 2 inches .
4) Sleeve length shall be not less than 12 inches for dampers without jackshafts and shall be not less than 16 inches for dampers with jackshafts.
5) Sleeve material shall match adjacent duct.

h. Additional Corrosion Protection for Corrosive Environments:

1) Provide anodized finish for aluminum surfaces in contact with airstream. Anodized finish shall be a minimum of 0.0007 inch thick.
2) Axles, damper linkage, and hardware shall be constructed of Type 316L stainless steel.

2.3 ROUND CONTROL DAMPERS

A. Round Dampers, Sleeve Type:
1) Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Greenheck,
b. Ruskin

2) Performance:

a. Leakage: Leakage shall not exceed 0.15 cfm/in. of perimeter blade at 4-in. wg differential static pressure.
b. Pressure Drop: 0.02-in. wg at 1500 fpm across a 12-inch damper when tested according to AMCA 500-D, figure 5.3.
c. Velocity: Up to 4000 fpm.
d. Temperature: Minus 25 to plus 200 deg F.
e. Pressure Rating: 8-in. wg for sizes through 12 inches, 6-in. wg for larger sizes.

3) Construction:

a. Frame:

1) Material: stainless steel, 0.04 in thick.
2) Outward rolled stiffener beads positioned approximately 1 inch inboard of each end.
3) Sleeve-type connection for mating to adjacent ductwork.
4) Size Range: 4 to 24 inches.
5) Length not less than 7 inches.
6) Provide 2-inch sheet metal stand-off for mounting actuator.

b. Blade: Double-thickness circular flat blades sandwiched together and constructed of stainless steel.
c. Blade Seal: Polyethylene foam seal sandwiched between two sides of blades and fully encompassing blade edge.
d. Axle: 0.5-inch- diameter stainless steel, mechanically attached to blade.
e. Bearings: Stainless steel sleeve pressed into frame.

2.4 GENERAL CONTROL-DAMPER ACTUATORS REQUIREMENTS

A. Actuators shall operate related damper(s) with sufficient reserve power to provide smooth modulating action or two-position action and proper speed of response at velocity and pressure conditions to which the damper is subjected.

B. Actuators shall produce sufficient power and torque to close off against the maximum system pressures encountered. Actuators shall be sized to close off against the fan shutoff pressure as a minimum requirement.

C. The total damper area operated by an actuator shall not exceed 80 percent of manufacturer's maximum area rating.

D. Provide one actuator for each damper assembly where possible. Multiple actuators required to drive a single damper assembly shall operate in unison.

E. Avoid the use of excessively oversized actuators which could overdrive and cause linkage failure when the damper blade has reached either its full open or closed position.

F. Use jackshafts and shaft couplings in lieu of blade-to-blade linkages when driving axially aligned damper sections.

G. Provide mounting hardware and linkages for connecting actuator to damper.

H. Select actuators to fail in desired position in the event of a power failure.

2.5 ELECTRIC AND ELECTRONIC CONTROL DAMPER ACTUATORS

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

1) Belimo Aircontrols (USA), Inc.
2) Honeywell Building Solutions; Honeywell International, Inc.
3) Siemens Industry, Inc., Building Technologies Division.

B. Type: Motor operated, with or without gears, electric and electronic.

C. Voltage:

1) 24 V.
2) Actuator shall deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
3) Actuator shall function properly within a range of 85 to 120 percent of nameplate voltage.

D. Construction:

1) Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2) 100 up to 400 W: Gears ground steel, oil immersed, shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3) Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

E. Field Adjustment:

1) Spring return actuators shall be easily switchable from fail open to fail closed in the field without replacement.
2) Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

F. Two-Position Actuators: Single direction, spring return or reversing type.

G. Modulating Actuators:

1) Capable of stopping at all points across full range, and starting in either direction from any point in range.
2) Control Input Signal:
   a. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.

H. Position Feedback:

1) Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2) Equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.
3) Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

I. Fail-Safe:

1) Where indicated, provide actuator to fail to an end position.
2) Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3) Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

J. Integral Overload Protection:

1) Provide against overload throughout the entire operating range in both directions.
2) Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

K. Damper Attachment:

1) Unless otherwise required for damper interface, provide actuator designed to be directly coupled to damper shaft without need for connecting linkages.
2) Attach actuator to damper drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3) Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

L. Temperature and Humidity:

1) Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F .
2) Humidity: Suitable for humidity range encountered by application; minimum operating range shall be from 5 to 95 percent relative humidity, non-condensing.

M. Enclosure:

1) Suitable for ambient conditions encountered by application.
2) NEMA 250, Type 2 for indoor and protected applications.
3) NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4) Provide actuator enclosure with a heater and controller where required by application.

N. Stroke Time:

1) Operate damper from fully closed to fully open within 60 seconds.
2) Operate damper from fully open to fully closed within 60 seconds.
3) Move damper to failed position within 15 seconds.
4) Select operating speed to be compatible with equipment and system operation.

5) Actuators operating in smoke control systems comply with governing code and NFPA requirements.

O. Sound:

1) Spring Return: 62 dBA.
2) Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for dampers and instruments installed in duct systems to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

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

3.2 CONTROL-DAMPER APPLICATIONS

A. Control Dampers:

B. See Drawings.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Properly support dampers and actuators, tubing, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a400 lb force.

C. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

D. Seal penetrations made in fire-rated and acoustically rated assemblies.

E. Fastening Hardware:

1) Stillson wrenches, pliers, or other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2) Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.

3) Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

F. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

G. Corrosive Environments:

1) Use products that are suitable for environment to which they will be subjected.

2) Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
3) When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4) Where actuators are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 CONTROL DAMPERS

A. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

B. Clearance:

1) Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.
2) Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

C. Service Access:

1) Dampers and actuators shall be accessible for visual inspection and service.

2) Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Section 233300 "Air Duct Accessories."

D. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

E. Attach actuator(s) to damper drive shaft.

F. For duct-mounted and equipment-mounted dampers installed outside of equipment, install a visible and accessible indication of damper position from outside.

3.6 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with damper identification on damper.

3.8 CHECKOUT PROCEDURES

A. Control-Damper Checkout:

1) Check installed products before continuity tests, leak tests, and calibration.
2) Check dampers for proper location and accessibility.
3) Verify that control dampers are installed correctly for flow direction.
4) Verify that proper blade alignment, either parallel or opposed, has been provided.
5) Verify that damper frame attachment is properly secured and sealed.
6) Verify that damper actuator and linkage attachment are secure.
7) Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8) Verify that damper blade travel is unobstructed.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING:

A. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

C. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION

SECTION 23 09 93.11 - SEQUENCE OF OPERATIONS FOR HVAC

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. Section includes control sequences for HVAC systems, subsystems, and equipment.

1.3 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

1.4 ACTION SUBMITTALS

A. Product Data:

1) An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2) A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1) Riser diagrams showing control network layout, communication protocol, and wire types.
2) Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3) Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.5 PLUMBING CONTROL SEQUENCES

A. Water Heater Pump(s):

1) See Controls drawings.

B. Water Heater (s):

1) See Controls drawings.

1.6 ENERGY RERCOVERY VENTILATOR CONTROL SEQUENCES

A. See controls drawings.

1.7 TERMINAL UNIT OPERATING SEQUENCE

A. Unit Heater, Electric:

1) See Controls drawings.

2)

B. Radiant Heating Panel, Indoor Electric:

1) See Controls drawings.

C. Radiant Heating Panel, Outdoor Electric:

1) See Controls Drawings.

D. Radiators Baseboard, Electric:

1) See Controls drawings.

1.8 VENTILATION SEQUENCES

A. Exhaust Fan:

1) See Controls Drawings.

B. Kitchen Exhaust Fan:

1) See Controls Drawings.

1.9 VRF UNIT SEQUENCES

1) See Controls Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 23 31 13 - METAL DUCTS

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. Section Includes:

1) Single-wall rectangular ducts and fittings.
2) Single-wall round ducts and fittings.
3) Sheet metal materials.
4) Duct liner.
5) Sealants and gaskets.
6) Hangers and supports.
7) Seismic-restraint devices.

B. Related Sections:

1) Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC for testing, adjusting, and balancing requirements for metal ducts.
2) Section 23 33 00 - Air Duct Accessories for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1) Liners and adhesives.
2) Sealants and gaskets.
3) Seismic-restraint devices.

B. Shop Drawings:

1) Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2) Factory- and shop-fabricated ducts and fittings.
3) Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4) Elevation of bottom of ducts.
5) Dimensions of all duct runs from building grid lines.
6) Fittings.
7) Reinforcement and spacing.

8) Seam and joint construction.
9) Penetrations through fire-rated and other partitions.
10) Equipment installation based on equipment being used on Project.
11) Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12) Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
13) .

C. Delegated-Design Submittal:

1) Sheet metal thicknesses.
2) Joint and seam construction and sealing.
3) Reinforcement details and spacing.
4) Materials, fabrication, assembly, and spacing of hangers and supports.
5) Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. , and coordinated with all building trades.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1) AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2)
3) AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. n criteria indicated in "Duct Schedule" Article.

C. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. Seismically brace duct hangers and supports in accordance with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1) Seismic Hazard Level (SHL): **D**.

D. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

F. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

G. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1) Construct ducts of galvanized sheet steel unless otherwise indicated.
2) For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1) For ducts with longest side less than 36 inches , select joint types in accordance with Figure 2-1.
2) For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
3)

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1) Construct ducts of galvanized sheet steel unless otherwise indicated.
2) For ducts exposed to weather, construct of Type 304 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. ndards - Metal and Flexible."

1) Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1) Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1) Galvanized Coating Designation: G90 .
2) Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1) Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

D. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches .

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed; SAINT-GOBAIN.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.

2) Maximum Thermal Conductivity:

a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3) Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
4) Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Insulation Pins and Washers:

1) Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2) Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1) Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2) Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3) Butt transverse joints without gaps, and coat joint with adhesive.
4) Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5) Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6) Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm or greater.
7) Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8) Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9) Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

   a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10) Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1) Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2) Tape Width: 4 inches .

3) Sealant: Modified styrene acrylic.
4) Water resistant.
5) Mold and mildew resistant.
6) Maximum Static-Pressure Class: 10 inch wg , positive and negative.
7) Service: Indoor and outdoor.
8) Service Temperature: Minus 40 to plus 200 deg F.
9) Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10)
11)

C. Water-Based Joint and Seam Sealant:

1) Application Method: Brush on.
2) Solids Content: Minimum 65 percent.
3) Shore A Hardness: Minimum 20.
4) Water resistant.
5) Mold and mildew resistant.
6) VOC: Maximum 75 g/L (less water).
7) Maximum Static-Pressure Class: 10 inch wg , positive and negative.
8) Service: Indoor or outdoor.
9) Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C920.

1) General: Single-component, acid-curing, silicone, elastomeric.
2) Type: S.
3) Grade: NS.
4) Class: 25.
5) Use: O.

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1) Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2) EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3) Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 , "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1) Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2) Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3) Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Ductmate Industries, Inc.
2) Hilti Inc.
3) Kinetics Noise Control, Inc.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1) Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A492, stainless-steel cables with end connections made of galvanized-steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Reinforcing steel angle clamped to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested in accordance with ASTM E488/E488M.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. e indicated.

D. Install ducts in maximum practical lengths with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch , plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches .

K. Install fire**,** combination fire/smoke**,** and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

L. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

N. Elbows: Use long-radius elbows wherever they fit.

1) Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2) Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

O. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1) Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2) Outdoor, Supply-Air Ducts: Seal Class A.
3) Outdoor, Exhaust Ducts: Seal Class C.
4) Outdoor, Return-Air Ducts: Seal Class C.
5) Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
6) Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg : Seal Class B.
7) Conditioned Space, Exhaust Ducts: Seal Class B.
8) Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1) Where practical, install concrete inserts before placing concrete.
2) Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3) Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4) Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5) Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 , "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet .

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1) Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2) Brace a change of direction longer than 12 feet .

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1) Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2) Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3) Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4) Set anchors to manufacturer's recommended torque, using a torque wrench.
5) Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1) Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2) Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
3) Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
4) Test for leaks before applying external insulation.
5) Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6) Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1) Visually inspect duct system to ensure that no visible contaminants are present.
2) Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1) Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2) Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3) Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1) When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2) When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1) Air outlets and inlets (registers, grilles, and diffusers).
2) Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3) Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4) Coils and related components.

5) Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6) Supply-air ducts, dampers, actuators, and turning vanes.
7) Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1) Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2) Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3) Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4) Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5) Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6) Provide drainage and cleanup for wash-down procedures.
7) Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.10 STARTUP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1) Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1) Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive 2- inch wg .
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round: 2.

2) Ducts Connected to Constant-Volume Air-Handling Units:

a. Pressure Class: Positive 2- inch wg .
b. Minimum SMACNA Seal Class: A.

c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round: 2.

C. Return Ducts:

1) Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2- inch wg .
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

D. Exhaust Ducts:

1) Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

a. Pressure Class: Negative 2- inch wg .
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

2) Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2- inch wg .
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 2.
d. SMACNA Leakage Class for Round and Flat Oval: 2.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1) Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2- inch wg .
b. Minimum SMACNA Seal Class: B.
c. SMACNA Leakage Class for Rectangular: 8.
d. SMACNA Leakage Class for Round: 8.

F. Intermediate Reinforcement:

1) Galvanized-Steel Ducts: Galvanized steel.

G. Liner:
1) Transfer Ducts: Fibrous glass, Type I, 1 inch(es) thick.

H. Elbow Configuration:

1) Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2) Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3) Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm : 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

I. Branch Configuration:

1) Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2) Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm : Conical tap.

END OF SECTION

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SECTION 23 33 00 - AIR DUCT 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. Section Includes:

1) Backdraft and pressure relief dampers.
2)
3) Manual volume dampers.
4) Fire dampers.
5) Smoke dampers.
6) Combination fire and smoke dampers.
7) Flange connectors.
8) Turning vanes.
9) Remote damper operators.
10) Duct-mounted access doors.
11) Duct access panel assemblies.
12) Flexible connectors.
13) Duct accessory hardware.

B. Related Requirements:

1) Section 23 33 46 - Flexible Ducts, for insulated and non-insulated flexible ducts.
2) Section 23 37 23 - HVAC Gravity Ventilators, for roof-mounted ventilator caps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1) For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1) Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, or BIM model, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. nd access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

C. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 90A and NFPA 90B.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1) Greenheck Fan Corporation.
2) Nailor Industries Inc.
3) Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. Description: Gravity balanced.

C. Performance:

1) Maximum Air Velocity: 1250 fpm .
2) Maximum System Pressure: 2 inches wg .
3)
4) Leakage:

a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
d. Class III: Leakage shall not exceed 40 cfm/sq. ft. against 1-inch wg differential static pressure.

D. Construction:

1) Frame:

a. Hat shaped.
b. 16-gauge- thick, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.

2) Blades:

a. Multiple single-piece blades.
b. Center pivoted, maximum 6-inch width, 16-gauge- thick, galvanized sheet steel with sealed edges.

3) Blade Action: Parallel.

E. Blade Seals: Neoprene, mechanically locked.

F. Blade Axles:

1) Material: Stainless steel.
2) Diameter: 0.20 inch .

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

I. Bearings: Steel ball or synthetic pivot bushings.

J. Damper Actuator - Electric:

1) Electric - 24 V ac.
2) UL 873 plenum rated.
3) Two position with fail-safe spring return.

a. Sufficient motor torque and spring torque to drive damper fully closed with adequate force to achieve required damper seal.
b. Minimum 90-degree drive rotation.

4) Clockwise or counterclockwise drive rotation as required for application.
5) Environmental Operating Range:

a. Temperature: Minus 40 to plus 130 deg F.
b. Humidity: 5 to 95 percent relative humidity noncondensing.

6) Environmental Enclosure: NEMA 2.
7) Actuator to be factory mounted and provided with a single-point wiring connection.

K. Controllers, Electrical Devices, and Wiring:
1) Electrical Connection: 24 V, 60 Hz.

L. Accessories:

1) Adjustment device to permit setting for varying differential static pressure.
2) Counterweights and spring-assist kits for vertical airflow installations.
3) Chain pulls.
4) Screen Mounting:

a. Front mounted in sleeve.

1) Sleeve Thickness: 20 gauge minimum.
2) Sleeve Length: 6 inches minimum.

5) Screen Material: Galvanized steel.
6) Screen Type: Bird.
7) 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Greenheck Fan Corporation.
b. McGill AirFlow LLC.
c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

2) Performance:

a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

3) Construction:

a. Linkage out of airstream.
b. Suitable for horizontal or vertical airflow applications.

4) Frames:

a. Hat-shaped, 16-gauge- thick, galvanized sheet steel.

b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5) Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized steel; 16 gauge thick.

6) Blade Axles: Stainless steel.
7) Bearings:

a. Stainless steel sleeve.
b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8) Tie Bars and Brackets: Galvanized steel.
9) Locking device to hold damper blades in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. McGill AirFlow LLC.
b. Nailor Industries Inc.
c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

2) Performance:

a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

3) Construction:

a. Linkage out of airstream.
b. Suitable for horizontal or vertical airflow applications.

4) Frames:

a. Hat-shaped, 0.10-inch- thick, aluminum sheet channels.
b. Flanges for attaching to walls and flangeless frames for installing in ducts.

5) Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.

6) Blade Axles: Stainless steel.
7) Bearings:

a. Stainless steel sleeve.
b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

8) Tie Bars and Brackets: Aluminum.
9) Locking device to hold damper blades in a fixed position without vibration.

C. Low-Leakage, Steel, Manual Volume Dampers:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Greenheck Fan Corporation.
b. Nailor Industries Inc.
c. Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

2) Performance:
a. Leakage:
1) Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

3) Construction:

a. Linkage: Out of airstream.
b. Suitable for horizontal or vertical airflow applications.

4) Frames:

a. Hat, U, or angle shaped.
b. Thickness: 16-gauge galvanized sheet steel.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5) Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized, roll-formed steel; 16 gauge thick.

6) Blade Edging Seals:

a. Closed-cell neoprene.
b. Inflatable seal blade edging or replaceable rubber seals.

7) Blade Jamb Seals: Neoprene.
8) Blade Axles: Stainless steel.
9) Bearings:

a. Stainless steel sleeve.
b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.

10) Tie Bars and Brackets: Galvanized steel.
11) Locking device to hold damper blades in a fixed position without vibration.

D. Jackshaft:

1) Size: 0.5-inch diameter.
2) Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3) Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

E. Damper Hardware:

1) Zinc-plated, die-cast core with dial and handle, made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2) Include center hole to suit damper operating-rod size.
3) Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

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

1) Greenheck Fan Corporation.
2) Pottorff.
3) Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. Type: Static; rated and labeled in accordance with UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed galvanized sheet steel,. Material gauge is to be in accordance with UL listing.

I. Horizontal Dampers: Include blade lock and stainless steel closure spring.

J. Heat-Responsive Device:

1) Replaceable, 165 deg F rated, fusible links.

2.5 COMBINATION FIRE AND SMOKE DAMPERS

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

1) Greenheck Fan Corporation.
2) Pottorff.
3) Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. General Requirements:

1) Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2) Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3) Unless otherwise indicated, use parallel-blade configuration.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Performance:

1) AMCA Certification: Test and rate in accordance with AMCE Publication 511.
2) Leakage:
   a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.

3) Pressure Drop: 0.05 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
4) Velocity: Up to 3000 fpm .
5) Temperature: Minus 25 to plus 180 deg F .
6) Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

F. Construction:

1) Suitable or horizontal or vertical airflow applications.
2) Linkage out of airstream.
3) Frame:

   a. Hat shaped.
   b. Galvanized sheet steel, with welded corners and mounting flange.
   c. Gauge is to be in accordance with UL listing.

4) Blades:

   a. Roll-formed, horizontal, v-groove, galvanized sheet steel.
   b. Maximum width and gauge in accordance with UL listing.

5) Blade Edging Seals:

a. Silicone rubber.

6) Blade Jamb Seal: Flexible stainless steel, compression type.
7) Blade Axles: 1/2-inch- diameter; **galvanized steel**; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
8) Bearings:

a. Stainless steel sleeve.

G. Mounting Sleeve:

1) Factory installed, galvanized sheet steel.
2) Length to suit wall or floor application with factory-furnished silicone caulking.
3) Gauge in accordance with UL listing.

H. Heat-Responsive Device:

1) Resettable, 165 deg F rated, fire-closure device.

I. Damper Actuator - Electric:

1) Electric - 24 V ac.
2) UL 873, plenum rated.
3) Designed to operate in smoke-control systems complying with UL 555S requirements.
4) Two position with fail-safe spring return.

a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
b. Maximum 15-second full-stroke closure.
c. Minimum 90-degree drive rotation.

5) Clockwise or counterclockwise drive rotation as required for application.
6) Environmental Operating Range:

a. Temperature: Minus 40 to plus 130 deg F .
b. Humidity: 5 to 95 percent relative humidity noncondensing.

7) Environmental Enclosure: NEMA 2.
8) Actuator to be factory mounted and provided with single-point wiring connection.

J. Controllers, Electrical Devices, and Wiring:
1) Electrical Connection: 24 V, 60 Hz.

K. Accessories:

1) Auxiliary switches for signaling or position indication.
2) Momentary test switch, remote mounted.

3) Smoke Detector: Integral, factory wired for single-point connection.

2.6 FLANGE CONNECTORS

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

1) CL WARD & Family Inc.
2) Ductmate Industries, Inc; a DMI company.
3) Ward Industries; a brand of Hart & Cooley, LLC.

B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.7 TURNING VANES

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

1) Aero-Dyne Sound Control Co.
2) Ductmate Industries, Inc; a DMI company.
3) Duro Dyne Inc.

B. Manufactured Turning Vanes for Metal Ducts: Fabricate curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1) Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

E. Vane Construction:

1) Single wall.

2.8 REMOTE DAMPER OPERATORS

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

1) DynAir; a Carlisle Company.
2) METALAIRE, Inc.
3) Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Steel.

2.9 DUCT-MOUNTED ACCESS DOORS

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

1) Ductmate Industries, Inc; a DMI company.
2) Duro Dyne Inc.
3) Ruskin; Air Distribution Technologies, Inc.; Johnson Controls, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 7-3, "Access Doors - Round Duct."

1) Door:

a. Double wall, rectangular.
b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
c. 24-gauge- thick galvanized steel or 0.032-inch thick aluminum door panel.
d. Vision panel.
e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
f. Fabricate doors airtight and suitable for duct pressure class.

2) Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum frame.

3) Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

c. Access Doors up to 24 by 48 Inches : Three hinges and two compression latches with outside and inside handles.
d. Access Doors Larger Than 24 by 48 Inches : Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1) Door and Frame Material: Galvanized sheet steel.

a. 24-gauge- thick galvanized steel door panel.

2) Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3) Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4) Factory set at 3.0 to 8.0 inches wg .
5) Doors close when pressures are within set-point range.
6) Hinge: Continuous piano.
7) Latches: Cam.
8) Seal: Neoprene or foam rubber.
9) Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES

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

1) CL WARD & Family Inc.
2) Ductmate Industries, Inc; a DMI company.
3) Flame Gard, Inc.

B. Access panels used in cooking applications:

1) Labeled compliant to NFPA 96 for grease duct access doors.
2) Labeled in accordance with UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 16-gauge carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96, grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F .

F. Minimum Pressure Rating: **10 inches wg** positive or negative.

2.11 FLEXIBLE CONNECTORS

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

1) CL WARD & Family Inc.
2) Ductmate Industries, Inc; a DMI company.
3) Duro Dyne Inc.

B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Materials: Flame-retardant or noncombustible fabrics.

E. Coatings and Adhesives: Comply with UL 181, Class 1.

F. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

G. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1) Minimum Weight: 26 oz./sq. yd. .
2) Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3) Service Temperature: Minus 40 to plus 200 deg F .

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1) Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2) Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3) Minimum Additional Travel: 50 percent of the required deflection at rated load.
4) Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5) Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6) Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7) Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 DUCT ACCESSORY HARDWARE

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

1) CL WARD & Family Inc.
2) Ductmate Industries, Inc; a DMI company.
3) Duro Dyne Inc.

B. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1) Galvanized Coating Designation: G90 .
2) Exposed-Surface Finish: Mill phosphatized.

B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209 , Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221 , Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches .

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.

C. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1) Install steel volume dampers in steel ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.

G. Install fire and smoke dampers in accordance with UL listing.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1) On both sides of duct coils.
2) Upstream from duct filters.
3) At outdoor-air intakes and mixed-air plenums.
4) At drain pans and seals.
5) Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6) Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7) At each change in direction and at maximum 50-ft. spacing.
8) Upstream and downstream from turning vanes.
9) Control devices requiring inspection.
10) Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:

1) One-Hand or Inspection Access: 8 by 5 inches .
2) Two-Hand Access: 12 by 6 inches .
3) Head and Hand Access: 18 by 10 inches .
4) Head and Shoulders Access: 21 by 14 inches .
5) Body Access: 25 by 14 inches .
6) Body plus Ladder Access: 25 by 17 inches .

K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Install duct test holes where required for testing and balancing purposes.

O. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1) Operate dampers to verify full range of movement.
2) Inspect locations of access doors, and verify that size and location of access doors are adequate to perform required operation.
3) Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4) Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5) Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 33 46 - FLEXIBLE DUCTS

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. Section Includes:
1) Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.

1) Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

B. ans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

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

1) Flexmaster U.S.A., Inc.
2) JP Lamborn Co.
3) Thermaflex; a Flex-Tek Group company.

B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.

1) Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2) Maximum Air Velocity: 4000 fpm .
3) Temperature Range: Minus 10 to plus 160 deg F .
4) Insulation R-Value: R6.

C. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1) Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2) Maximum Air Velocity: 4000 fpm.
3) Temperature Range: Minus 20 to plus 210 deg F .
4) Insulation R-Value: R6.

2.3 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with draw bands.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:

1) Install ducts fully extended.
2) Do not bend ducts across sharp corners.
3) Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4) Avoid contact with metal fixtures, water lines, pipes, or conduits.
5) Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:

1) Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2) Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3) Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4) Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

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23 34 16 - CENTRIFUGAL HVAC FANS

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. Section Includes:
   1) Square in-line centrifugal fans.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1) Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
   2) Rated capacities, operating characteristics, and furnished specialties and accessories.
   3) Certified fan performance curves with system operating conditions indicated.
   4) Certified fan sound-power ratings.
   5) Motor ratings and electrical characteristics, plus motor and electrical accessories.
   6) Material thickness and finishes, including color charts.
   7) Dampers, including housings, linkages, and operators.
   8) Fan speed controllers.

B. Shop Drawings:

   1) Include plans, elevations, sections, and attachment details.
   2) Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3) Include diagrams for power, signal, and control wiring.
   4) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

C. Delegated Design Submittal: For vibration isolation, supports, and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   1) Design Calculations: Calculate requirements for selecting vibration isolators, supports,, and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

C. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1) Basis for Certification: Indicate whether withstand certification is based on actual shake table test of assembled components or on calculation.
2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions

1) Base fan-performance ratings on the following:

a. Ambient Temperature: 68 deg F dry bulb.
b. Altitude: 500 feet above sea level.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance and design criteria indicated.

D. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."

1) The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2) Component Importance Factor: **1.5** .

2.2 SQUARE IN-LINE CENTRIFUGAL FANS

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

1) Aerovent; a division of Twin City Fan Companies, Ltd.
2) Greenheck Fan Corporation.
3) Loren Cook Company.

B. Description: Square in-line centrifugal fans.

C. Housing:

1) Housing Material: Galvanized steel.
2) Housing Coating: None.
3) Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

F. Motor Enclosure: Totally enclosed, fan cooled.

G. Accessories:

1) Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2) Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3) Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4) Companion Flanges: For inlet and outlet duct connections.
5) Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.4 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 301.

B.

C.

D. Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1) Install floor- or roof-mounted centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2) Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
3) Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

E. Install units with clearances for service and maintenance.

F. Label fans according to requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK AND PIPING CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 233300 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1) Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2) Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Lubricate bearings.

C. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.6 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust

3.7 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.

1) Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3) Fans and components will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 23 37 13.13 - AIR DIFFUSERS

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. Section Includes:
   1) Round ceiling diffusers. Louver face diffusers.

B. Related Requirements:

   1) Section 23 33 00 - Air Duct Accessories, for fire and smoke dampers and volume-control dampers not integral to diffusers.
   2) Section 23 37 13.23 - Air Registers and Grilles, for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1) Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2) Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. ans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1) Ceiling suspension assembly members.
   2) Method of attaching hangers to building structure.
   3) Size and location of initial access modules for acoustical tile.
   4) Ceiling-mounted items including lighting fixtures, diffusers, grilles, sprinklers, access panels, and special moldings.
   5) Duct access panels.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

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

1) Price Industries Limited.
2) Shoemaker Mfg. Co.
3) Titus; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, color selected by Architect .

E. Face Style: Four cone.

F. Mounting: Duct connection.

G. Pattern: Three-position horizontal.

2.2 LOUVER FACE DIFFUSERS

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

1) Price Industries Limited.
2) Shoemaker Mfg. Co.
3) Titus; brand of Johnson Controls International plc, Global Products.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Material: Aluminum.

D. Finish: Baked enamel, color selected by Architect.

E. Face Size: See schedule.

F. Mounting: Surface with beveled frame or T-bar, see schedule.

G. Pattern: See schedule for core style.

H. Accessories:

1) Square to round neck adaptor.

2) Adjustable pattern vanes.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. tion, notify Architect for a determination of final location.

D. ination of final location.

E. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

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SECTION 23 37 13.23 - REGISTERS AND GRILLES

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. Section Includes:

1) Adjustable blade face grilles.
2) Eggcrate grilles.

B. Related Requirements:

1) Section 23 33 00 - Air Duct Accessories, for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2) Section 23 37 13.13 - Air Diffusers, for various types of air diffusers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1) Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2) Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plPlans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1) Ceiling suspension assembly members.
2) Method of attaching hangers to building structure.
3) Size and location of initial access modules for acoustical tile.
4) Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5) Duct access panels.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 GRILLES

A. Adjustable Blade Face Grille:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
b. Price Industries Limited.
c. Titus; brand of Johnson Controls International plc, Global Products.

2) Material: Aluminum.
3) Finish: Baked enamel, white.
4) Face Blade Arrangement: Horizontal spaced 3/4 inch apart.
5) Core Construction: Integral.
6) Rear-Blade Arrangement: Vertical spaced 3/4 inch apart.
7) Frame: 1-1/4 inches wide.

8) Mounting: Countersunk screw or Lay in.

B. Eggcrate Grille:

1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Krueger-HVAC; brand of Johnson Controls International plc, Global Products.
b. Price Industries Limited.
c. Titus; brand of Johnson Controls International plc, Global Products.

2) Material: Aluminum.
3) Finish: Baked enamel, white.
4) Face Arrangement: 1/2 inch x 1/2 inch x 1/2 inch eggcrate core.
5) Core Construction: [Integral].
6) Frame: 1-1/4 inches wide.
7) Mounting: Countersunk screw or Lay in.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. stallation, notify Architect for a determination of final location.

D. n of final location.

E. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

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SECTION 23 72 23.13 - PACKAGED INDOOR HEAT WHEEL ENERGY RECOVERY UNITS

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. Section Includes:

1) Heat wheels in packaged energy-recovery units.

B. Related Requirements:

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1) Include packaged, indoor, heat wheel, energy-recovery-unit rated capacities, operating characteristics, furnished specialties, and accessories.
2) Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.

B. Shop Drawings: For air-to-air energy recovery equipment.

1) Include plans, elevations, sections, details, and mounting attachment details.
2) Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3) Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For air-to-air energy-recovery equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1) Detail fabrication and assembly of air-to-air energy-recovery equipment.

2) Vibration-Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
3) Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration-isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. ons, and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

C. Seismic Qualification Data: Certificates, for air-to-air energy-recovery equipment, accessories, and components, from manufacturer.

1) Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2) Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3) Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy-recovery equipment to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1) Filters: One set(s) of each type of filter specified.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, indoor, heat wheel energy-recovery units that fail in materials or workmanship within specified warranty period.

1) Warranty Period for Packaged Energy-Recovery Units: 18 months from date of Substantial Completion.
2) Warranty Period for Energy-Recovery Wheel: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

C. Comply with ASTM E84 or UL 723.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration-isolation controls and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

E. Seismic Performance: Packaged, indoor, heat wheel energy-recovery units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 .

1) The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2) Component Importance Factor: 1.0.

2.2 PACKAGED, INDOOR, HEAT WHEEL ENERGY-RECOVERY UNITS

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

1) Greenheck Fan Corporation.
2) Loren Cook Company.
3) Ruskin Rooftop Systems.

B. Source Limitations: Obtain packaged, indoor, heat wheel energy-recovery units from single manufacturer.

C. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1- inch- thick, R-4 R-value thermal insulation, knockouts for electrical connections, exterior drain connection, and lifting lugs.

E. Heat Wheel:

1) Casing:

   a. Manufacturer's standard construction with standard factory finish.
   b. Slide-in, slide-out cassette style for easy access.
   c. Casing seals on periphery of rotor and on duct divider and purge section.
   d. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings.

2) Rotor: Aluminum or polymer segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel coating.
3) Drive: Fractional horsepower motor and gear reducer and self-adjusting multilink belt around outside of rotor.

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Supply and Exhaust Fans: Forward-curved, centrifugal fan with restrained, spring isolators .

   1) Motor and Drive: Direct driven, with speed changed by variable-frequency motor controller].
   2) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   3) Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Filters:

   1) Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
   2) UL Compliance: Comply with UL 900.
   3) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
   4) Filter Media Frame: Beverage board with perforated metal retainer or metal grid on outlet side.
   5) Filter-Mounting Frames: Arranged with access doors or panels on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

H. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls, so only external connections are required during installation.

   1) Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
   2) Include nonfused disconnect switches.

2.3 CONTROLS

A. Control Panel: Solid-state, programmable, microprocessor-based control unit for wall mounting

B. Starting relay, factory mounted and wired, and manual motor starter for field wiring.

C. Carbon Dioxide Sensor: Adjustable control from 600 to 2000 ppm for wall mounting, with digital display and computer/building management system interface to energize unit.

D. Economizer Control: Stop wheel rotation when conditions are favorable for economizer operation.

E. Enthalpy sensor.

F. Rotation sensor and alarm.

G. Dirty filter switch.

H. Low-Voltage Transformer: Integral transformer to provide control voltage to unit from primary incoming electrical service.

I. Variable-Speed Control: Factory mounted and wired, permitting input of field-connected, 4-20 mA or 1-10-V control signal.

J. Variable-Speed Control: Factory mounted and wired, with building pressure sensor to vary rotor speed and maintain setpoint.

2.4 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended application.

B. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060 .

C. Fan Performance Rating: Comply with AMCA 211 and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency according to AMCA 210/ASHRAE 51.

D. Fan Sound Rating: Comply with AMCA 301 or AHRI 260 (IP). Air-handling unit fan sound ratings shall comply with AMCA 301 or AHRI 260 (IP).

E. UL Compliance:

1) Packaged heat recovery ventilators shall comply with requirements in UL 1812 or UL 1815.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before packaged, indoor, heat wheel energy-recovery unit installation. Replace with new insulation materials any filter media that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

A. Install packaged, indoor, heat wheel energy-recovery units, so supply and exhaust airstreams flow in opposite directions, and rotation is away from exhaust side to purge section to supply side.

1) Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2) Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3) Access doors and panels are specified in Section 233300 "Air Duct Accessories."

B. Equipment Mounting:
1) Comply with requirements for vibration-isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Suspended Units: Suspend and brace units from structural-steel support frame, using threaded steel rods and spring hangers. Comply with requirements for vibration-isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

D. Install units with clearances for service and maintenance.

E. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements for ductwork according to Section 233113 "Metal Ducts."

B. Connect duct to units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

C. Isolation Dampers: Install isolation dampers according to Section 230923.12 "Control Dampers."

3.4

3.5 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished with units but not factory mounted.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1) Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:

   1) Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Packaged, indoor, heat wheel energy-recovery equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1) Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. Adjust moving parts to function smoothly and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy-recovery units.

END OF SECTION

SECTION 23 81 29 - VARIABLE-REFRIGERANT-FLOW HVAC SYSTEMS

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provision

1.2 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, recessed, ceiling-mounted units.
2. Indoor, suspended, ceiling-mounted units.
3. Outdoor, air-source, heat-pump units.
4. Outdoor, air-source heat recovery units.
5. System controls.
6. System refrigerant and oil.
7. System condensate drain piping.
8. System refrigerant piping.
9. Metal hangers and supports.
10. Metal framing systems.
11. Fastener systems.
12. Pipe stands.
13. Equipment stands.
14. Miscellaneous support materials.
15. Piping and tubing insulation.
16. System control cable and raceways.

1.3 DEFINITIONS

A. Air-Conditioning System Operation: System capable of operation with all zones in cooling only.

B. Heat-Pump System Operation: System capable of operation with all zones in either heating or cooling, but not with simultaneous heating and cooling zones that transfer heat between zones.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

D. Two-Pipe System Design: One refrigerant vapor line and one refrigerant liquid line connect a single outdoor unit or multiple manifold outdoor units in a single system to associated system indoor units. One refrigerant liquid line and refrigerant vapor line connect associated indoor units.

E. VRF: Variable refrigerant flow.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.

4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.

5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unitcontrol.

6. Include description of control software features.

7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.

8. Include refrigerant type and data sheets showing compliance with requirements indicated.

9. For system design software.

10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

4. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.

5. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittals:

1. Include design calculations with corresponding diagram of refrigerant piping and tubing sizing for each system installed.

2. Include design calculations with corresponding floor plans indicating that refrigerant concentration limits are within allowable limits of ASHRAE 15 and governing codes.

3. Include calculations showing that system travel distance for refrigerant piping and controls cabling are within horizontal and vertical travel distances set by manufacturer. Provide a comparison table for each system installed.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, elevations, sections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. ections, and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.

2. Structural floors, roofs and associated members to which equipment, piping, ductwork, cables, and conduit will be attached.

3. Size and location of initial access modules for acoustical tile.

4. Wall-mounted controllers located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.

5. Size and location of access doors and panels installed behind walls and inaccessible ceilings for products installed behind walls and requiring access.

6. Items penetrating finished ceiling including the following:

a. Luminaires.

b. Air outlets and inlets.

c. Service access panels.

C. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

a. Retain copies of Installer certificates on-site and make available on request.

2. For VRF HVAC system manufacturer.

3. For VRF HVAC system provider.

D. Seismic Qualification Data: Certificates, for equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Product Test Reports: Where tests are required, for each product, for tests performed by manufacturer and witnessed by a qualified testing agency.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranties: For manufacturer's warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On CD or DVD, USB media, or approved cloud storage platform, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters:

a. One set(s) for each unit with replaceable filters.

b. One set(s) for each unit type and unique size of washable filters.

2. Indoor Units: One for each unique size and type installed.

3. Controllers for Indoor Units: One for each unique controller type installed.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.

2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of five years within time of bid.

3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.

4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.

5. Having full-time in-house employees for the following:

a. Product research and development.

b. Product and application engineering.

c. Product manufacturing, testing, and quality control.

d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.

e. Owner training.

B. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.

2. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.

3. Demonstrated past experience on five projects of similar complexity, scope, and value.

    a. Each person assigned to Project shall have demonstrated past experience.

4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.

5. Service and maintenance staff assigned to support Project during warranty period.

6. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.

7. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.

2. Installer certification shall be valid and current for duration of Project.

3. Retain copies of Installer certificates on-site and make available on request.

4. Each person assigned to Project shall have demonstrated past experience.

    a. Demonstrated past experience with products being installed for period within three consecutive years before time of bid.

    b. Demonstrated past experience on five projects of similar complexity, scope, and value.

D. ISO Compliance: System equipment and components furnished by VRF HVAC system manufacturer shall be manufactured in an ISO 9001 and ISO 14001 facility.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in a clean and dry place.

B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.

C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.

D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.

1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remover coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.

E. Replace installed products damaged during construction.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.

b. Faulty operation.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.

b. For Parts, Including Controls: Five year(s) from date of Substantial Completion.

c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

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

1. Daikin Applied.

2. LG Electronics USA, Inc.; LG Electronics Inc.

3. Mitsubishi Electric & Electronics USA, Inc.

B. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:

1. Indoor and outdoor units, including accessories.

2. Controls and software.

3. Refrigerant isolation valves.

4. Specialty refrigerant pipe fittings.

2.2 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units,outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.

1. Two-pipe system design.

2. System(s) operation, air-conditioning heat pump as indicated on Drawings.

3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 **and products listed in AHRI directory**.

D. ASHRAE Compliance:

1. ASHRAE 15: For safety code for mechanical refrigeration.

2. ASHRAE 62.1: For indoor air quality.

3. ASHRAE 135: For control network protocol with remote communication.

4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.

2.3 PERFORMANCE REQUIREMENTS

A. Service Access:

1. Provide and document service access requirements.

2. Locate equipment, system isolation valves, and other system components that require service and inspection in easily accessible locations. Avoid locations that are difficult to access if possible.

3. Where serviceable components are installed behind walls and above inaccessible ceilings, provide finished assembly with access doors or panels to gain access. Properly size the openings to allow for service, removal, and replacement.

4. If less than full and unrestricted access is provided, locate components within an 18-inch reach of the finished assembly.

5. Where ladder access is required to service elevated components, provide an installation that provides for sufficient access within ladder manufacturer's written instructions for use.

6. Comply with OSHA regulations.

B. System Design and Installation Requirements:

1. Design and install systems indicated according to manufacturer's recommendations and written instructions.

2. Where manufacturer's requirements differ from requirements indicated, contact Architect for direction. The most stringent requirements should apply unless otherwise directed in writing by Architect.

C. Isolation of Equipment: Provide isolation valves to isolate each indoor unit and outdoor unit for service, removal, and replacement without interrupting system operation.

D. System Capacity Ratio: The sum of connected capacity of all indoor units shall be within the following range of outdoor-unit rated capacity:

1. Not less than 60 percent.

2. Not more than 130 percent.

3. Range acceptable to manufacturer.

E. System Turndown: Stable operation down to 20 percent of outdoor-unit capacity.

F. System Auto Refrigerant Charge: Each system shall have an automatic refrigerant charge function to ensure the proper amount of refrigerant is installed in system.

G. Outdoor Conditions:

1. Suitable for outdoor ambient conditions encountered.

a. Design equipment and supports to withstand wind loads of governing code and ASCE/SEI 7.

b. Design equipment and supports to withstand snow and ice loads of governing code and ASCE/SEI 7.

c. Provide corrosion-resistant coating for components and supports where located in coastal or industrial climates that are known to be harmful to materials and finishes.

2. Maximum System Operating Outdoor Temperature: 100 °F.

3. Minimum System Operating Outdoor Temperature: 25 °F.

H. Thermal Movements: Allow for controlled thermal movements from ambient, surface, and system temperature changes.

I. Capacities and Characteristics: As indicated on Drawings.

2.4 INDOOR, RECESSED, CEILING-MOUNTED UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.

2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.

3. Mounting: Manufacturer-designed provisions for field installation.

4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.

2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.

3. Coil Tubes: Copper, of diameter and thickness required by performance.

4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.

5. Internal Tubing: Copper tubing with brazed joints.

6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

7. Field Piping Connections: Manufacturer's standard.

8. Factory Charge: Dehydrated air or nitrogen.

9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.

3. Field Piping Connection: Non-ferrous material.

E. Fan and Motor Assembly:

1. Fan(s):

a. Direct-drive arrangement.

b. Single or multiple fans connected to a common motor shaft and driven by a single motor.

c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.

d. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.

3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.

5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:

1. Access: Bottom, to accommodate filter replacement without the need for tools.

2. Efficiency: MERV 4.

3. Media:

a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

b. Washable: Manufacturer's standard filter with antimicrobial treatment.

G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.

1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.

a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.

b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.

H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.

I. Unit Accessories:

1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

.

J. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, filter service notification, drain assembly high water level safety shutdown and notification.

4. Communication: Network communication with other indoor units and outdoor unit(s).

5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

K. Unit Electrical:

1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

6. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

2.5 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.

2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.

3. All units installed shall be from the same product development generation.

B. Cabinet:

1. Galvanized steel and coated with a corrosion-resistant finish.

a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.

2. Mounting: Manufacturer-designed provisions for field installation.

3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.

2. Protection: Integral protection against the following:

a. High refrigerant pressure.

b. Low oil level.

c. High oil temperature.

d. Thermal and overload.

e. Voltage fluctuations.

f. Phase failure and phase reversal.

g. Short cycling.

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3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.

4. Vibration Control: Integral isolation to dampen vibration transmission.

5. Oil management system to ensure safe and proper lubrication over entire operating range.

6. Crankcase heaters with integral control to maintain safe operating temperature.

7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:

a. Casing: Aluminum, galvanized, or stainless steel.

b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.

c. Tubes: Copper, of diameter and thickness required by performance.

2. Coating: **Corrosion resistant.**

3. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.

a. Direct-drive arrangement.

b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.

c. **Statically and** dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.

3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.

4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.

5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.

6. Vibration Control: Integral isolation to dampen vibration transmission.

F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Factory-Installed Sensors:

a. Refrigerant suction temperature.

b. Refrigerant discharge temperature.

c. Outdoor air temperature.

d. Refrigerant high pressure.

e. Refrigerant low pressure.

f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, night setback control.

5. Communication: Network communication with indoor units and other outdoor unit(s).

6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

H. Unit Electrical:

1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.

3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.

5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

I. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.

2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.

3. Field Piping Connections: Manufacturer's standard.

4. Factory Charge: Dehydrated air or nitrogen.

5. Testing: Factory pressure tested and verified to be without leaks.

2.6 SYSTEM CONTROLS

A. General Requirements:

1. Network: Indoor units and outdoor units shall include integral controls and connect through a TIA-485A control network.

2. Network Communication Protocol: Manufacturer proprietary control communication between interconnected units.

3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:

a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.

b. Integration devices shall be connected to local uninterruptible power supply unit(s) to provide at least 5 minutes of battery backup operation after a power loss.

c. Integration shall include monitoring scheduling.

4. Operator Interface:

a. Operators shall interface with system and unit controls through the following:

1) Operator interfaces integral to controllers.

b. Users shall be capable of interface with controllers for indoor units control to extent privileges are enabled. Control features available to users shall include the following:

1) On/off control.

2) Temperature set-point adjustment.

B. VRF HVAC System Operator Software for PC:

1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.

2. F HVAC system(s) from a single dedicated Owner-furnished PC.

3. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.

4. Plan views shall show building plans with location of indoor units and identification superimposed on plans.

5. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.

6. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.

7. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

8. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.

9. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.

10. Supports Multiple Languages: **English** .

11. Supports Imperial and Metric Temperature Units: Fahrenheit and Celsius.

12. Displays service notifications and error codes.

13. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.

14. Monitors and displays cumulative operating time of indoor units.

15. Able to disable and enable operation of individual controllers for indoor units.

16. Information displayed on individual controllers shall also be available for display.

17. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

C. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.

    a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.

3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

    a. Sets schedule for daily, weekly, and annual events.

    b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.

6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.

7. Service diagnostics tool.

8. Able to disable and enable operation of individual controllers for indoor units.

9. Information displayed on individual controllers shall also be available for display through central controller.

10. Information displayed for outdoor units, including refrigerant high and low pressures.

11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.

12. Operator interface through a backlit, high-resolution color display touch panel.

D. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.

2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.

3. Temperature Units: Fahrenheit and Celsius.

4. On/Off: Turns indoor unit on or off.

5. Hold: Hold operation settings until hold is released.

6. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.

7. Temperature Display: 1-degree increments.

8. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments between40 to 99°F.

9. Relative Humidity Display: 1 percent increments.

10. Relative Humidity Set-Point: Adjustable in 1 percent increments between30% to 95%.

11. Fan Speed Setting: Select between available options furnished with the unit.

12. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.

13. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.

14. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.

15. Occupancy detection.

16. Service Notification Display: "Filter".

17. Service Run Tests: Limit use by service personnel to troubleshoot operation.

18. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.

19. User and Service Passwords: Capable of preventing adjustments by unauthorized users.

20. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.

21. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

2.7 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

2. ASHRAE 34, Class A1 refrigerant classification.

3. R-410a.

B. Oil:

1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

2.8 SYSTEM CONDENSATE DRAIN PIPING

A. If more than one material is listed, material selection is Contractor's option.

B. Copper Tubing:

1. Drawn-Temper Tubing: According to ASTM B88, Type L or Type DWV according to ASTM B306.

2. Wrought-Copper Fittings: ASME B16.22.

3. Wrought-Copper Unions: ASME B16.22.

4. Solder Filler Metals: ASTM B32, lead-free alloys, and water-flushable flux according to ASTM B813.

C. CPVC plastic pipe according to ASTM F441/F441M, Schedule 40, with socket-type pipe fittings according to ASTM F438 and solvent cement according to ASTM F493.

D. PVC plastic pipe according to ASTM D1785, Schedule 40, with socket-type pipe fittings according to ASTM D2466 and solvent cement according to ASTM D2564, primer according to ASTM F656.

2.9 SYSTEM REFRIGERANT PIPING

A. Refrigerant Piping:

1. Copper Tube: ASTM B280, Type ACR.

2. Wrought-Copper Fittings: ASME B16.22.

3. Brazing Filler Metals: AWS A5.8/A5.8M.

B. Refrigerant Tubing Kits:

1. Furnished by VRF HVAC system manufacturer.

2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.

3. Standard one-piece length for connecting to indoor units.

4. Pre-insulated with flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.

5. Factory Charge: Dehydrated air or nitrogen.

C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

D. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.

2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.

3. Valve Connections: Flare or sweat depending on size.

2.10 METAL HANGERS AND SUPPORTS

A. Copper Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized or copper-coated steel.

B. Plastic Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, galvanized-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.

2.11 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.

3. Channels: Continuous slotted carbon-steel channel with inturned lips.

4. Channel Width: Selected for applicable load criteria.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel for use indoors and of stainless steel for use outdoors.

7. Metallic Coating for Use Indoors: No coating.

8. Plastic Coating for Use Outdoors: PVC.

2.12 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded, zinc-coated steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: stainless steel.

2. Outdoor Applications: Stainless steel.

2.13 MISCELLANEOUS SUPPORT MATERIALS

A. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi , 28-day compressive strength.

B. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

C. Threaded Rods: Continuously threaded. Zinc-plated steel or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar material as rods.

2.14 PIPING AND TUBING INSULATION

A. Comply with requirements in Section 230719 "HVAC Piping Insulation" for system piping insulation requirements.

2.15 SYSTEM CONTROL CABLE

A. Cable Rating: Listed and labeled for application according to NFPA 70.

1. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

a. Flame Travel Distance: 60 inches or less.

b. Peak Optical Smoke Density: 0.5 or less.

c. Average Optical Smoke Density: 0.15 or less.

2. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

3. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

B. Low-Voltage Control Cabling:

1. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

a. One pair, twisted, No. 16 AWG, stranded (19x29) or No. 18 AWG, stranded (19x30) tinned-copper conductors as required by VRF HVAC system manufacturer.

b. PVC insulation.

c. Braided or foil shielded.

d. PVC jacket.

e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

f. Flame Resistance: Comply with NFPA 262.

C. TIA-485A Network Cabling:

1. Plenum-Rated Cable: NFPA 70, Type CMP.

a. Paired, one pair, No. 22 AWG, stranded (7x30) tinned-copper conductors.

b. Fluorinated ethylene propylene insulation.

c. Unshielded.

d. Fluorinated ethylene propylene jacket.

e. NFPA 262 includes the standard flame-resistance test criteria in common use for cables and conductors.

f. Flame Resistance: NFPA 262.

D. Ethernet Network Cabling: TIA-568-C.2 Category 6a cable with RJ-45 connectors.

1. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of category cable indicated.

2. Conductors: 100-ohm, 23 AWG solid copper.

3. Shielding: Shielded twisted pairs (FTP).

4. Cable Rating: By application.

5. Jacket: thermoplastic.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for control wiring and cable raceways.

2.16 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.

2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.

2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.

b. ASTM D2794 for minimum impact resistance of 100 in-lb .

c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: Immersion.

3. Thickness: 1 mil .

4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.17 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect factory-assembled equipment.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports for historical record. Submit reports only if requested.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

G. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 EQUIPMENT INSTALLATION, GENERAL

A. Clearance:

1. Maintain manufacturer's recommended clearances for service and maintenance.

2. Maintain clearances required by governing code.

B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.

1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

C. Equipment Restraint Installation: Install equipment with seismic-restraint device. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 INSTALLATION OF INDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.

C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.

D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.

E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.

F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.

G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch .

3.4 INSTALLATION OF OUTDOOR UNITS

A. Install units to be level and plumb while providing a neat and finished appearance.

B. Pad-Mounted Installations: Install outdoor units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

1. Attachment: Install anchor bolts to elevations required for proper attachment to supported equipment.

2. Grouting: Place grout under equipment supports and make bearing surface smooth.

3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping and tubing to permit valve servicing.

F. Install piping and tubing at indicated slopes.

G. Install piping and tubing free of sags.

H. Install fittings for changes in direction and branch connections.

I. Install piping and tubing to allow application of insulation.

J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.

K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

A. General Requirements for Drain Piping and Tubing:

1. Install a union in piping at each threaded unit connection.

2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.

3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:

a. Details indicated on Drawings.

b. Manufacturer's requirements.

c. Governing codes.

d. In the absence of requirements, comply with requirements of ASHRAE handbooks.

4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.

5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.

B. Gravity Drains:

1. Slope piping from unit connection toward drain termination at a constant slope of not less than one percent.

C. Pumped Drains:

1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

3.7 INSTALLATION OF REFRIGERANT PIPING

A. Refrigerant Tubing Kits:

1. Unroll and straighten tubing to suit installation. Deviations in straightness of exposed tubing shall be unnoticeable to observer.

2. Support tubing using hangers and supports indicated at intervals not to exceed 5 feet . Minimum rod size, 1/4 inch .

3. Prepare tubing ends and make mating connections to provide a pressure tight and leak-free installation.

B. Install refrigerant piping according to ASHRAE 15 and governing codes.

C. Select system components with pressure rating equal to or greater than system operating pressure.

D. Install piping as short and direct as possible, with a minimum number of joints and fittings.

E. Arrange piping to allow inspection and service of equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

F. Install refrigerant piping and tubing in protective conduit where installed belowground.

G. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

H. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps to entrain oil in vertical runs.

4. Liquid lines may be installed level.

I. When brazing, remove or protect components that could be damaged by heat.

J. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

K. Joint Construction:

1. Ream ends of tubes and remove burrs.

2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.

3. Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

   a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.

   b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

3.8 INSTALLATION OF METAL HANGERS AND SUPPORTS

A. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

B. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Comply with MFMA-103 for metal framing system selections and applications that are not specified.

E. Fastener System Installation:

1. Install powder-actuated fasteners, for use in lightweight concrete or concrete slabs less than 4 inches thick, in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

3. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel.

1. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Piping and Tubing Insulation:

1. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

2. Shield Dimensions for Pipe: Not less than the following:

a. NPS 1/4 to NPS 3-1/2 : 12 inches long and 0.048 inch thick.

M. Horizontal-Piping Hangers and Supports: Install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 .

2. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 , to allow off-center closure for hanger installation before pipe erection.

3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

4. Multiple horizontal pipes located indoors may use metal framing systems with split clamp attachment for each pipe in lieu if individual clevis hangers.

5. Pipe stands for horizontal pipes located outdoors.

6. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

7. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

N. Horizontal Piping Hanger Spacing and Rod Size: Install hangers for drawn-temper copper piping with the following maximum horizontal spacing and minimum rod sizes:

1. Sizes through NPS 3/4 : Maximum span, 5 feet ; minimum rod size, 1/4 inch .

2. NPS 1 : Maximum span, 6 feet ; minimum rod size, 1/4 inch .

3. NPS 1-1/4 : Maximum span, 7 feet ; minimum rod size, 3/8 inch .

4. NPS 1-1/2 : Maximum span, 8 feet ; minimum rod size, 3/8 inch .

5. NPS 2 : Maximum span, 8 feet ; minimum rod size, 3/8 inch .

6. NPS 2-1/2 : Maximum span, 9 feet ; minimum rod size, 3/8 inch .

7. NPS 3 and Larger: Maximum span, 10 feet ; minimum rod size, 3/8 inch .

O. Plastic Pipe Hanger and Support Spacing:

1. Space hangers and supports according to pipe manufacturer's written instructions for service conditions.

2. Maximum spacing, 5 feet ; minimum rod size, 1/4 inch .

P. Vertical-Piping Clamps: Install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): If longer ends are required for riser clamps.

Q. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified.

R. Use hangers, supports, and attachments with galvanized coatings unless otherwise indicated.

S. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

T. Trim excess length of continuous-thread hanger and support rods to 1 inch .

U. Hanger-Rod Attachments: Install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

V. Building Attachments: Install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb .

    b. Medium (MSS Type 32): 1500 lb .

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

3.9 INSTALLATION OF PIPING AND TUBING INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated. Installation to maintain a continuous vapor barrier.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 INSTALLATION OF DUCT, ACCESSORIES, AND AIR OUTLETS

A. Where installing ductwork adjacent to equipment, allow space for service and maintenance.

B. Comply with requirements for metal ducts specified in Section 233113 "Metal Ducts."

C. Comply with requirements for nonmetal ducts specified in Section 233116 "Nonmetal Ducts."

D. Comply with requirements for air duct accessories specified in Section 233300 "Air Duct Accessories."

E. Comply with requirements for flexible ducts specified in Section 233346 "Flexible Ducts."

F. Comply with requirements for air diffusers specified in Section 233713.13 "Air Diffusers."

G. Comply with requirements for registers and grilles specified in Section 233713.23 "Registers and Grilles."

3.11 ELECTRICAL INSTALLATION

A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.

B. To extent electrical power is required for system equipment, components, and controls, and is not indicated on Drawings and addressed in the Specifications, the design for such electrical power shall be delegated to VRF HVAC system provider.

1. Delegated design of electrical power to equipment, components and controls, and associated installation shall be included at no additional cost to Owner.

C. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

E. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

F. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.

2. Locate nameplate or label where easily visible.

G. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or revised in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2. Flexible metal conduit shall not be used.

H. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

I. Install manufactured conduit sweeps and long-radius elbows if possible.

J. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.12 SOFTWARE

A. Cybersecurity:

1. Software:

a. Coordinate security requirements with IT department.

b. Ensure that latest stable software release is installed and properly operating.

c. Disable or change default passwords to password using a combination of uppercase and lower letters, numbers, and symbols at least eight characters in length. Record passwords and turn over to party responsible for system operation and administration.

2. Hardware:

a. Coordinate location and access requirements with IT department.

b. Enable highest level of wireless encryption that is compatible with Owner's ICT network.

c. Disable dual network connections.

3.13 INSTALLATION OF SYSTEM CONTROL CABLE

A. Comply with NECA 1.

B. Installation Method:

1. Install cables in raceways except as follows:

a. Within equipment and associated control enclosures.

b. In accessible ceiling spaces where open cable installation method may be used.

c. In gypsum board partitions where cable may be enclosed within wall cavity.

2. Conceal raceway and cables except in unfinished spaces.

C. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.

2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."

3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.

4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable.

5. Cables serving a common system may be grouped in a common raceway. Install control cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.

6. 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.

7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.

8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.

9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.

11. Support: Do not allow cables to lie on removable ceiling tiles or access panels.

12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

13. Provide strain relief.

14. Keep runs short. Allow extra length for connecting to terminals.

15. Do not bend cables in a radius less than 10 times the cable OD.

16. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.

17. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

D. Balanced Twisted-Pair Cable Installation:

1. Comply with TIA-568-C.2.

2. Do not untwist balanced twisted-pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

E. Open-Cable Installation:

1. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.

2. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources: Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded cable from potential EMI sources including electrical power wiring and equipment.

3.14 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.15 GROUNDING INSTALLATION

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.16 IDENTIFICATION

A. Identify system equipment, piping, tubing, and valves. Comply with requirements for identification specified in Section 230553 "Identification for HVAC Piping and Equipment."

B. Identify system electrical and controls components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify each control cable on each end and at each terminal with a number-coded identification tag. Each cable shall have a unique tag.

3.17 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.

1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.

2. Manufacturer shall provide on-site visits during the course of construction at installation milestones indicated. System Installer shall coordinate each visit in advance to give manufacturer sufficient notice to plan the visit.

3. Kick-off Meeting:

a. Meeting shall include system Installer and other related trades with sole purpose of reviewing VRF HVAC system installation requirements and close coordination required to make a successful installation.

b. Meeting shall be held at Project site and scheduled at a mutually agreed to time that occurs before the start of any part of system installation.

c. Meeting shall cover the following as a minimum requirement:

1) Review of latest issue of Contract Documents, Drawings, and Specifications, relevant to VRF HVAC systems.

2) Manufacturer's installation requirements specific to systems being installed.

3) Review of all relevant VRF HVAC system submittals, including delegated-design submittals.

4) Required field activities related installation of VRF HVAC system.

5) Project team communication protocol, contact information, and exchange of responsibilities for each party involved, including manufacturer, supplier, system Installer, and other related trades.

4. Site Visits: Activities for each site visit shall include the following:

a. Meet with VRF HVAC system Installer to discuss field activities, issues, and suggested methods to result in a successful installation.

b. Offer technical support to Installer and related trades as related to VRF system(s) being installed.

c. Review progress of VRF HVAC system(s) installation for strict compliance with manufacturer's requirements.

d. Advise and if necessary assist Installer with updating related refrigerant calculations and system documentation.

e. Issue a report for each visit, documenting the visit.

1) Report to include name and contact information of individual making the visit.

2) Date(s) and time frames while on-site.

3) Names and contact information of people meeting with while on-site.

4) Clearly identify and list each separate issue that requires resolution. For each issue, provide a unique identification number, relevant importance, specific location or equipment identification, description of issue, recommended corrective action, and follow-up requirements needed. Include a digital photo for clarification if deemed to be beneficial.

5. Final Inspection before Startup:

a. Before inspection, Installer to provide written request to manufacturer stating the system is fully installed according manufacturer's requirements and ready for final inspection.

b. All system equipment and operating components shall be inspected. If components are inaccessible for inspection, they shall be made accessible before the final inspection can be completed.

c. Manufacturer shall provide a comprehensive inspection of all equipment and each operating component that comprise the complete system(s). Inspection

shall follow a detailed checklist specific to each equipment and operating component.

d. Inspection reports for indoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Controller type and model controlling unit.

13) Controller location.

14) Temperature settings and readings within an acceptable range.

15) Humidity settings and readings within an acceptable range.

16) Condensate removal acceptable.

17) Fan settings and readings within an acceptable range.

18) Unit airflow direction within an acceptable range.

19) If applicable, fan external static pressure setting.

20) Filter type and condition acceptable.

21) Noise level within an acceptable range.

22) Refrigerant piping properly connected and insulated.

23) Condensate drain piping properly connected and insulated.

24) If applicable, ductwork properly connected.

25) If applicable, external interlocks properly connected.

26) Remarks.

e. Inspection reports for outdoor units shall include, but not be limited to, the following:

1) Unit designation on Drawings.

2) Manufacturer model number.

3) Serial number.

4) Network address, if applicable.

5) Each equipment setting.

6) Mounting, supports, and restraints properly installed.

7) Proper service clearance provided.

8) Wiring and power connections correct.

9) Line-voltage reading(s) within acceptable range.

10) Wiring and controls connections correct.

11) Low-voltage reading(s) within an acceptable range.

12) Condensate removal acceptable.

13) Noise level within an acceptable range.

14) Refrigerant piping properly connected and insulated.

15) Condensate drain piping properly connected and insulated.

16) Remarks.

f. Installer shall provide manufacturer with the requested documentation and technical support during inspection.

g. Installer shall correct observed deficiencies found by the inspection.

h. Upon completing the on-site inspection, manufacturer shall provide a written report with complete documentation describing each inspection step, the result, and any corrective action required.

i. If corrective action is required by Installer that cannot be completed during the same visit, provide additional visits, as required, until deficiencies are resolved and systems are deemed ready for startup.

j. Final report shall indicate the system(s) inspected are installed according to manufacturer's requirements and are ready for startup.

B. Perform the following tests and inspections with the assistance of manufacturer's service representative:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and re-test until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Refrigerant Tubing Positive Pressure Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.5 times VRF HVAC system operating pressure, but not less than 600 psig , using dry nitrogen.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 24 hours. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.

4. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.

b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.

c. Detailed description of extent of tubing tested.

d. Date and time at start of test.

e. Test pressure at start of test.

f. Outdoor temperature at start of test.

g. Name of person ending test, company name, phone number, and e-mail address.

h. Date and time at end of test.

i. Test pressure at end of test.

j. Outdoor temperature at end of test.

k. Remarks:

5. Submit test reports for Project record.

D. Refrigerant Tubing Evacuation Testing:

1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.

2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.

3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of **one** hour(s) with no change.

4. Prepare test report to record the following information for each test:

a. Name of person starting test, company name, phone number, and e-mail address.

b. Name of manufacturer's service representative witnessing test, company name, phone number, and e-mail address.

c. Detailed description of extent of tubing tested.

d. Date and time at start of test.

e. Test pressure at start of test.

f. Outdoor temperature at start of test.

g. Name of person ending test, company name, phone number, and e-mail address.

h. Date and time at end of test.

i. Test pressure at end of test.

j. Outdoor temperature at end of test.

k. Remarks:

5. Submit test reports for Project record.

6. Upon successful completion of evacuation testing, system shall be charged with refrigerant.

E. System Refrigerant Charge:

1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.

2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.

3. System refrigerant charging shall be witnessed by system manufacturer's representative.

4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.

F. Products will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.18 STARTUP SERVICE

A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be a factory-trained and -authorized service representative of VRF HVAC system manufacturer.

2. Complete startup service of each separate system.

3. Complete system startup service according to manufacturer's written instructions.

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

1. Check control communications of equipment and each operating component in system(s).

2. Check each indoor unit's response to demand for cooling and heating.

3. Check each indoor unit's response to changes in airflow settings.

4. Check each indoor unit and outdoor unit for proper condensate removal.

C. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.

1. Installer shall correct deficiencies found during startup service for reverification.

D. System Operation Report:

1. After completion of startup service, manufacturer shall issue a report for each separate system.

2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.

3. Manufacturer shall electronically record not less than Insert number hours of continuous operation of each system and submit with report for historical reference.

    a. All available system operating parameters shall be included in the information submitted.

E. Witness:

1. Invite Commissioning Agent to witness startup service procedures.

2. Provide written notice not less than 20 business days before start of startup service.

3.19 ADJUSTING

A. Adjust equipment and components to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.

C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.

3.20 PROTECTION

A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.

B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.

C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.

D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

3.21 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include two service visits for preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper

equipment and system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.22 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.23 DEMONSTRATION

A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.

B. Instructor:

1. Instructor shall be factory trained and certified by VRF HVAC system manufacturer with current training on the system(s), equipment, and controls that are installed.

2. Instructor's credentials shall be submitted for review by Commissioning Agent before scheduling training.

3. Instructor(s) primary job responsibility shall be Owner training.

4. Instructor(s) shall have not less than three years of training experience with VRF HVAC system manufacturer and past training experience on at least three projects of comparable size and complexity.

C. Schedule and Duration:

1. Schedule training with Owner at least 20 business days before first training session.

2. Training shall occur before Owner occupancy.

3. Training shall be held at mutually agreed date and time during normal business hours.

4. Each training day shall not exceed eight hours of training. Daily training schedule shall allow time for one-hour lunch period and 15-minute break after every two hours of training.

5. Perform not less than eight total hours of training.

D. Location: Owner shall provide a suitable on-site location to host classroom training.

E. Training Attendees: Assume three people.

F. Training Attendance: For record purposes, document training attendees at the start of each new training session. Record attendee's name, signature, phone number, and e-mail address.

G. Training Format: Individual training modules shall include classroom training followed by hands-on field demonstration and training.

H. Training Materials: Provide training materials in electronic format to each attendee.

1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.

I. Acceptance: Obtain Owner written acceptance that training is complete and requirements indicated have been satisfied.

END OF SECTION

SECTION 23 82 36 – FINNED TUBE RADIATION HEATERS

PART 1 -- GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes electric, baseboard and finned-tube radiation heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1) Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1) Include plans, elevations, sections, and details.

2) Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3) Include details and dimensions of custom-fabricated enclosures.

4) Indicate location and size of each field connection.

5) Indicate location and arrangement of integral controls.

6) Include enclosure joints, corner pieces, access doors, and other accessories.

7) Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1) Structural members, including wall construction, to which finned-tube radiation heaters will be attached.

2) Method of attaching finned-tube radiation heaters to building structure.

3) Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 -- PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATION HEATERS

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

1) Chromalox, Inc.

2) Marley Engineered Products.

3) QMark; Marley Engineered Products.

B. Description: Factory-packaged units constructed according to UL 499, UL 1030, and UL 2021

1) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Heating Elements: Nickel-chromium-wire heating element enclosed in metallic sheath mechanically bonded to fins, with high-temperature cutout and sensor running the full length of the element. Element supports shall eliminate thermal expansion noise.

1) Volts: See drawings.

2) Phase: See drawings.

3) Hertz: See drawings.

4) Heat Output: See drawings.

D. Enclosures: Minimum 0.024-inch-thick steel, removable front cover.

1) Full-height back.

2) Full-length damper.

3) End panel.

4) End caps.

5) Inside and outside corners.

6) Joiner pieces to snap together.

7) Enclosure Height: 6-3/4 inches

8) Enclosure Depth: 2-7/8 inches

9) Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.

10) Element Brackets: Primed and painted steel to support front panel and element.

E. Unit Controls: Integral line-voltage thermostat.

F. Accessories:

1) Filler sections without a heating element matching the adjacent enclosure.

2) Straight-blade-type receptacles complying with DSCC W-C-596G/GEN, NEMA WD 1, NEMA WD 6, and UL 498; in color selected by Architect.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before installation of finned-tube radiation heaters.

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

3.2 BASEBOARD RADIATION HEATER INSTALLATION

A. Install units level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

3.3 CONNECTIONS

A. Ground electric finned-tube radiation heaters according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1) Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

2) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 238239.19 – WALL AND CEALING UNIT HEATERS

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. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include details of anchorages and attachments to structure and to supported equipment.

4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

5. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

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

1. Chromalox, Inc.

2. Marley Engineered Products.

3. QMark; Marley Engineering Products

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Controls: Low-voltage relay with transformer kit.

B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION

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SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all Sections in Division 16, except as otherwise indicated.

C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.

D. The CONTRACTOR'S attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment Specifications, the WORK of instrumentation Sections, and the WORK of Section 26 05 10 – Electric Motors.

E. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the WORK of the various Sections of Division 16 is included as a part of the WORK under the respective Sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

F. Equipment supports and foundations shall be in conformance with the requirements of Section 46 01 00 – Equipment General Provisions.

1.2 REFERENCE STANDARDS

NEC (NFPA 70)	National Electrical Code
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)
WAC 296-46B	Electrical Safety Standards, Administration and Installation

A. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

B. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

C. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.3 SIGNAGE AND MARKINGS

A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

C. Warning Signs

1. 480 Volts Nominal, or Less

a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.

2. Greater than 480 Volts

a. Buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at greater than 480 volts nominal shall be lockable.

b. Provide permanent and conspicuous warning signs reading as follows: DANGER – HIGH VOLTAGE – KEEP OUT.

3. Mark indoor electrical installations that are open to unqualified persons and contain metal-enclosed switchgear, unit substations, transformers, and other similar associated equipment over 480 volts nominal, with appropriate caution signs.

4. Outside Branch Circuits and Feeders over 480 Volts

a. Post warning signs in plain view where unauthorized persons might come in contact with live parts: WARNING – HIGH VOLTAGE – KEEP OUT.

D. Isolating Switches

1. Provide isolating switches not interlocked with an approved circuit-interrupting device with a sign warning against opening them under load.

1.4 PUBLIC UTILITIES REQUIREMENTS

A. Contact the serving utility and verify compliance with requirements before construction.

B. Coordinate schedules and payments for WORK by utilities.

C. Where conduits and conductors in the WORK are indicated to be larger, heavier schedule, or have greater protective coating than utility requirements, provide the larger size, heavier schedule, or greater protection.

D. Provide electrical service as indicated and as required by the serving utility.

E. Verify and provide service conduits, fittings, transformer pad, grounding devices, and service wires not provided by the serving utility.

F. Verify with the utility the exact location of each service point and type of service, and pay charges levied by the serving utilities as part of the WORK.

1.5 PERMITS AND INSPECTION

A. Obtain permits and pay inspection fees according to the General Conditions.

1.6 CONTRACTOR SUBMITTALS

A. General

1. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

2. Custom-prepare Shop Drawings.

3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.

4. Cross out options not proposed or delete from the Shop Drawings.

B. Shop Drawings: Include the following:

1. Complete material lists stating manufacturer and brand name of each item or class of material.

2. Shop Drawings for grounding WORK not specifically indicated

3. Front, side, rear elevations, and top views with dimensional data

4. Location of conduit entrances and access plates

5. Component data

6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers

7. Method of anchoring, seismic requirements, weight

8. Types of materials and finish

9. Nameplates

10. Temperature limitations, as applicable

11. Voltage requirement, phase, and current, as applicable

12. Front and rear access requirements

13. Test reports

14. Grounding requirements

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass produced, non-custom manufactured material.

2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the ENGINEER a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.

2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

2. As-Built Drawings

a. Prepare as-built drawings, showing invert and top elevations and routing of duct banks and concealed below-grade electrical installations.

b. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

1.7 AREA DESIGNATIONS

A. General

1. Designations for raceway system enclosures shall comply with the requirements of Section 26 05 33 – Electrical Raceway Systems.

2. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections unless indicated otherwise.

3. Designations for other electrical WORK not included in the above Paragraphs shall be as follows:

AREA	MINIMUM NEMA ENCLOSURE CLASSIFICATION					
	1	3R	4	4X	12	Notes
Indoors					X	
Outdoors		X				Provide stainless steel for control panels, for eqpt not under a roof, where shown or listed

4. Designations for electrical WORK not included in the above Paragraphs shall be NEMA 4X.

B. Material Requirements

1. Provide sealing fittings at thermal boundaries in accordance with the NEC.

2. Construct NEMA 4X enclosures of Type 304 or 316 stainless steel.

3. Do not coat NEMA 4X enclosures.

4. Construct NEMA 1, 3R, and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

1.8 TESTS

A. The CONTRACTOR shall be responsible for factory and field tests indicated in Division 16, as required by the ENGINEER, and as required by other authorities having jurisdiction.

B. Furnish necessary testing equipment.

C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.

D. Reporting

1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.

2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.

E. Remove and replace equipment or material that fails a test, or, if the ENGINEER approves, repair and retested for compliance.

F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

1.9 DEMOLITION AND RELATED WORK

A. General

1. Perform electrical demolition WORK as indicated.

2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Drawings.

3. Coordinate with all trades regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.

B. Electrical Requirements for Removed Equipment

1. Remove dedicated wiring and exposed conduits back to the source.

2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring.

3. Remove power wiring from the power source to the first pullbox or manhole remote from the panel, and abandon in place the remaining wiring.

4. Encased Conduits

a. Abandon in place wiring routed through encased conduits.

b. Cut encased conduits flush to the floor and grout flush with the floor.

5. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters.

C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits.

D. Junction Boxes

1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.

2. Provide a junction box with a NEMA rating in accordance with the area in which it is located, and sized as required.

3. Properly identify wires and terminals before disconnection.

E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR'S property and shall be disposed of off- Site.

F. Identification

1. Where motor control centers, panelboards, etc. are indicated to have components, assemblies, or circuits removed and reconnected, provide the affected MCC compartments with new engraved nameplates worded as indicated and matching the existing, or modify the panelboard schedule to indicate the revised circuits.

2. Pencil or magic marker markings directly on the equipment or enclosures will not be accepted.

1.10 CONSTRUCTION SEQUENCING

A. General

1. Because the continuance of facility operation during the project is critical, the CONTRACTOR shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.

2. Schedule the WORK, subject to OWNER's approval, to minimize required shutdown time.

3. Submit a written sequencing request, including the sequence and duration of activities to be performed during plant shutdown.

4. Switching, safety tagging, and the like, as required for plant shutdown or to isolate existing equipment, shall be performed by the CONTRACTOR.

5. In no case shall the CONTRACTOR begin any WORK in, on, or adjacent to existing equipment without written authorization from the ENGINEER.

B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.

2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.

3. Repair coatings to match existing.

4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

C. Existing Utilities

1. Exercise extreme caution when digging trenches to not damage existing underground utilities.

2. The cost of repairs of damages caused during construction shall be included as a part of the WORK.

D. Field Verifications

1. Visit the Site before submitting a Bid to become better acquainted with the WORK of this Contract.

2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The CONTRACTOR shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

4. The CONTRACTOR shall be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers.

5. The cost for the above verifications shall be included as part of the WORK.

E. Installation of Temporary Equipment

1. To facilitate the continuous operation of existing equipment, provide the temporary equipment as indicated.

2. Submit installation and connection details for review and acceptance by the ENGINEER.

3. Costs associated with these temporary installations shall be included as part of the WORK.

4. Temporary wiring and equipment shall remain the property of the CONTRACTOR unless indicated otherwise.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.

B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.

C. Provide similar items in the WORK as products of the same manufacturer.

D. Provide equipment and materials of industrial grade standard of construction.

E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.

F. On devices indicated to display dates, display the year as 4 digits.

G. Temperature Ratings of Equipment Terminations.

1. Provide terminations and lugs rated for use with 75-degree C conductors.

2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. Provide nuts, bolts, and washers constructed of stainless steel.

2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.

3. Struts

a. Construct struts for mounting of conduits and equipment of galvanized steel.

b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.

c. Strut Manufacturer, or Equal: **Unistrut**; **B-Line.**

4. End Caps

a. Provide plastic protective end caps for all exposed strut ends.

b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860.**

5. Anchors

a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

b. Wood plugs will not be accepted.

c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Star**.

2.3 ELECTRICAL IDENTIFICATION

A. Nameplates

1. Fabricate nameplates from white-letter, black-face laminated plastic engraving stock, such as **Formica Type ES-1** or equal.

2. Securely fasten each nameplate, using fasteners constructed of brass, cadmium-plated steel, or stainless steel, and screwed into inserts or tapped holes as required.

3. Provide engraved characters of the block style, with no characters smaller than 1/4 inch top to bottom.

B. Conductor and Equipment Identification

1. Provide imprinted plastic-coated cloth marking devices, such as manufactured by Brady, Thomas & Betts, or equal.

2. Alternatively, provide heat-shrunk plastic tubing, imprinted split-sleeve markers cemented in place.

PART 3 -- EXECUTION

3.1 GENERAL

A. Incidentals

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.

2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

B. Field Control of Location and Arrangement

1. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items.

2. Exact locations shall be determined by the CONTRACTOR in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

3. Follow the locations on the Drawings, however, as closely as possible.

4. Conduits

a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.

b. Provide exposed or encased routings as indicated, except conceal conduit in finished areas unless indicated otherwise.

c. Size conduits encased in a slab for conduit OD not to exceed 1/3 of the slab thickness, and lay out and space as to not impede concrete flow.

5. Placement

a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.

b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.

c. Where exact locations are not indicated, such locations will be determined by the ENGINEER.

d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.

e. Slightly adjust luminaire locations in order to avoid obstructions and to minimize shadows.

6. Circuits

a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the CONTRACTOR'S responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.

b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).

c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

C. Workmanship

1. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer and using workers skilled in the WORK.

2. Coordinate installation in the field with other trades in order to avoid interferences.

D. Protection of Equipment and Materials

1. Fully protect materials and equipment against damage from any cause.

2. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.

3. Keep moving parts clean and dry.

4. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

E. Provide raceways, wiring and appurtenances for the HVAC equipment in accordance with the equipment manufacturer's recommendations.

3.2 CORE DRILLING

A. Perform core drilling as required for the installation of raceways through concrete walls and floors.

B. Base the locations of floor penetrations, as may be required, on field conditions.

C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.

D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the OWNER prior to any core drilling activities.

E. Repair damage to encased conduits, wiring, and piping as part of the WORK.

3.3 CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for indoor floor-standing electrical equipment.

B. Extend housekeeping pads for equipment, including future units, 3-1/2 inches above the surrounding finished floor or grade, and one inch larger in both dimensions than the equipment, unless otherwise indicated.

C. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.

D. Extend housekeeping curbs to 3 inches above the finished floor or grade.

3.4 EQUIPMENT ANCHORING

A. Floor-supported, wall, or ceiling-hung equipment and conductors shall be anchored in place by methods that will meet seismic requirements in the area where the Project is located.

B. Provide wall-mounted panels that weigh more than 100 pounds or that are within 18 inches of the floor with fabricated steel support pedestals.

C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.

D. Provide transformers hung from 4-inch stud walls and weighing more than 100 pounds with auxiliary floor supports.

E. Manufacturer's Recommendations

1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.

2. Submit such recommendations as Shop Drawings as indicated.

3.5 EQUIPMENT IDENTIFICATION

A. Provide nameplates for panelboards, control and instrumentation panels, starters, switches, and pushbutton stations.

B. In addition to nameplates, equip control devices with standard collar-type legend plates.

C. Identify control devices within enclosures as indicated and similar to the subparagraph above.

D. Provide suitable inscribed finish plates for toggle switches that control loads out of sight of switches and for multi-switch locations of more than 2 switches.

E. Use equipment names and tag numbers, where indicated, on nameplates.

F. Provide typewritten circuit directories for panelboards, that accurately reflect the outlets connected to each circuit.

G. Terminal Blocks

1. Label termination points on terminal blocks by identifiers on the blocks.

2. Provide identifiers that have been preprinted by the terminal manufacturer or custom-printed.

3. Hand-lettered markers will not be accepted.

H. Tag distribution equipment, stand-alone disconnects, starters, and VFDs with appropriate arc-flash labels.

3.6 CLEANING

A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.

B. Remove temporary tags, markers, stickers, and the like.

C. Remove oil and grease spots with a non-flammable cleaning solvent, by carefully wiping and scraping cracks and corners.

D. Apply touch-up paint to scratches on panels and cabinets.

E. Vacuum-clean electrical cabinets and enclosures.

F. Clean luminaires inside and out.

G. Dispose cleaning debris and refuse off-Site.

END OF SECTION

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SECTION 26 01 10 – OPERATION AND MAINTENANCE DATA

PART 1 -- GENERAL

1.1 SUMMARY

A. Contractor shall obtain all electrical operation and maintenance data specified in Division 01 and Divisions 26, 27, 28, and 40 for inclusion in the Operation and Maintenance Manuals.

1.2 RELATED REQUIREMENTS

A. Comply with requirements of Operation and Maintenance Data and Manual requirements specified in Division 01.

1.3 PRODUCT DATA

A. Collect and submit manufacturer's product data for all equipment and prepackaged systems.

1.4 INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS

A. Collect and submit installation, operation and maintenance instructions for all equipment and prepackaged systems.

B. Obtain and submit additional comprehensive service manuals requested by the Province.

1.5 CONTRACTOR DESIGNED SYSTEM DATA

A. Prepare and submit Contractor designed system data for systems designed by Contractor.

1.6 CERTIFICATION

A. Collect and submit copies of following inspection certification reports:

1. Electrical System Inspection
2. Utility Company Inspection
3. Occupational Health and Safety Inspection
4. Fire Alarm Verification
5. Manufacturer’s test sheets

1.7 REPORTS

A. Collect and submit field reports including following:

1. Start-up and testing reports specified in Section 26 08 10 "Electrical Starting and Testing - General Requirements".
2. Contractor and manufacturer start-up and testing specified in Section 26 08 20, including Fire Alarm pre-verification report.
3. Test reports by contractors testing agent specified in Section 26 08 30.

4. Arc Flash, Short Circuit and Coordination Studies.

1.8 WARRANTIES

A. Collect and complete manufacturer's warranty certificates and submit original copies to the Minister.

PART 2 -- PRODUCTS (NOT USED)

PART 3 --EXECUTION (NOT USED)

END OF SECTION

SECTION 26 01 11 – OPERATION AND MAINTENANCE MANUAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Contractor shall obtain all specified operation and maintenance data. Using this data, Contractor shall prepare and submit operation and maintenance manuals as specified.

1.2 RELATED REQUIREMENTS

A. Comply with requirements of Operation and Maintenance Data and Manual requirements specified in Division 01.

1.3 FORMS

A. Obtain a current list of Alberta Infrastructure Equipment Identification Forms from the Minister. Use these forms in presenting Operation and Maintenance Data.

1.4 MANUAL SYSTEM CATEGORIES

A. Organize manual into the following major system categories:

1) PDS - Power Distribution System
2) LTG - Lighting Systems
3) COM - Communication Systems
4) FSS - Fire Safety Systems
5) INS – Instrumentation Systems
6) PLC – Programmable Logic Controllers and Control Panels

B. Provide master divider tabs and index for each major system category, with white tabs, 75 mm in length.

1.5 SUB-SYSTEM DIVISIONS

A. Divide major system categories into subsystems as follows:

1) PDS - Power Distribution System:
   a. Low Voltage Systems (Below 750 Volts)
   b. Motor Control Systems
   c. Uninterruptable Power System (UPS)

2) LTG - Lighting Systems:

a. Interior Lighting
b. Exterior Lighting
c. Lighting Control

3) COM – Communications Systems

a. SCADA Hardware
b. SCADA Software
c. Protocol Converters

4) FSS - Fire Safety Systems:

a. Fire Alarm System

5) INS – Instrumentation Systems

a. Process Instruments

6) PLC – Programmable Logic Controllers and Control Panels

a. PLC processor, cards, and chassis
b. Control Panel Cabinet(s)
c. Control Panel Interior and exterior works

7) Organize each sub-system into the following sections:

a. Operations Section
b. Maintenance Section
c. Contract Documentation Section
d. Standards Section

8) Provide an index and divider for each subsystem and section, colour coded as follows:

a. PDS Subsystems – Blue
b. LTG Subsystems - Yellow
c. COM Systems - Green
d. FSS Subsystems – Red
e. INS Systems – Purple
f. PLC – Orange

9) Use 45 mm tabs for each subsystem and 40 mm tabs for sections, use same colour for section tabs as for subsystem tabs.

1.6 OPERATIONS SECTION

A. In each system or category and/or subsystem, include an operations section which includes:

1) System Description
2) System Operating Instructions
3) Schematic Diagrams

4) Equipment Data Sheets

B. System Descriptions: prepare descriptions which, at least, includes the following:

1) Power Distribution System - PDS:

a. Calculated demand in kVA of entire system and on each transformer 150 kVA and above.
b. Measured current per phase at the main breaker.
c. Short Circuit analysis of entire system, including incoming fault level.
d. Protective Device Coordination study for entire system, including standby / backup generator system.
e. Identify Arc Flash hazards for the applicable systems and components.
f. Description of protection, transfer and metering scheme for both normal and standby / backup generator systems supported by schematic diagrams.
g. Calculated system operating power factor together with method of improvement and anticipated improvement.
h. Calculated demand in kVA of Standby / Backup Generator Power System.
i. Single line diagram of entire power system indicating all breaker, switches, protective devices and instrumentation.
j. Calculated demand on UPS systems where installed.
k. Breaker settings for all breakers.

2) Lighting Systems - LTG:

a. Interior Lighting:

i. Include following in description of interior lighting system:

1. Describes all drivers, ballast, light sources / lamps, and fixtures used.
2. Include description of diffusers / lenses / lighting photometrics and distribution patterns.
3. Include battery lighting units and exit lights.

b. Exterior Lighting:

i. Include following in description of exterior lighting:

1. Describe all drivers, ballast, light sources / lamps, and fixtures used.
2. Include description of diffusers / lenses / lighting photometrics and distribution patterns.

3) Lighting Control System:

a. Interior Lighting:

i. Describe method of switching. Include switching of corridors, large general use areas and any lighting connected to emergency or standby power, as well as any lighting contactor assemblies.
ii. Include settings of all occupancy, vacancy and daylight sensors.

b. Exterior Lighting:

i. Describe method of controlling exterior lighting (ie photocell, control station, etc.)
ii. Include location of all control equipment.
iii. Include settings of all occupancy, vacancy and daylight sensors.

4) Communication Systems - COM:

a. Description of all SCADA hardware components and systems.
b. Description of SCADA software.
c. IP scheme.
d. Description of network architecture.
e. Passwords and usernames.

5) Fire Safety Systems - FSS:

a. Fire Alarm System:

i. Manufacturer and model number of system.
ii. General description ie single or two stage, zoned, non-coded, etc.
iii. Interconnection to other system ie, security system, building management system in Division 23 etc.
iv. Fire alarm control unit.
v. Power supply for system.
vi. Communicators.
vii. Pull Stations.
viii. Heat Detectors.
ix. Smoke Detectors.
x. Signal Device - bell or speaker.
xi. Amplifiers (if speakers used).
xii. Door Holder.
xiii. Sprinkler flow and tamper devices.
xiv. End-of-line device.
xv. Printers.
xvi. Floor fire alarm panel.
xvii. Integral transient and memory protection.
xviii. Fault isolators.

6) Instrumentation Systems - INS:

a. Instrumentation System:

i. Manufacturer and model number of instruments.
ii. Instrument serial numbers.
iii. Instrument data sheets (As found in the specifications).
iv. Instrument data sheets (As supplied by the manufacturer).
v. Instrument commissioning and sign-off forms.
vi. List of parameters and setpoints.
vii. List of alarm setpoints.

7) PLC Systems - PLC:

a. Programmable Logic Controller System:

i. Overview of hardware and software.

1.7 SYSTEM OPERATING INSTRUCTIONS

A. Prepare system operating instructions, with the Manufacturers' and Suppliers bulletins as backup. Provide the following:

1) Power Distribution System - PDS:

a. Provide an overall description of operation of power system in both normal and standby / backup generator mode.
b. Automatic Power Factor improvement equipment detailing method of input summation, protection, switching and size of incremental increase/decrease in kVAR.
c. Protective schemes such as overcurrent, short circuit, undervoltage, ground fault, including lock out and restraint as applicable.
d. Transfer schemes both normal and standby / backup generator.
e. Standby / backup power generation, including load shedding and peak shaving.

2) Lighting Systems - LTG:

a. List type of lamps that can be used with ballasts where applicable, or replacement LED units to obtain results.
b. Photocell.

3) Communications Systems – COM:

a. Provide an overall network architecture.
b. Description of new process operation screens on the SCADA terminal.
c. Description of SCADA software.
d. Description of SCADA hardware.
e. Log-in and credentials.
f. Description of alarms, acknowledgement, and reset.

4) Fire Safety Systems - FSS:

a. Fire Alarm System:

i. Fire alarm control unit.
ii. Wiring class.
iii. Zoning.
iv. Programming instructions if microprocessor / addressable.
v. Supervisory zone operation.
vi. Systems trouble.
vii. System reset.
viii. CRT/Printer Operation.
ix. Communication.
x. First stage alarm:

1. System operation.
2. Auxiliary relay operation:

a. Smoke damper operation.
b. Fan shutdown.
c. Fire department "alert" or "alarm".

xi. Second stage alarm (where applicable):

1. Zone evacuation.
2. Automatic evacuation.
3. Signal silence.
4. Auxiliary relay operation (if different from first stage alarm).

5) Instrumentation Systems – INS:

a. Instrument passwords.
b. List of configurable parameters.
c. Instrument operation via displays and HMI's.

6) PLC Systems - PLC:

a. Programmable Logic Controller System:

i. Description of indicating lights on processor and what they mean.

1.8 SYSTEM SCHEMATICS

A. Include all schematics that are applicable, which will assist in operation and maintenance of system.

1.9 EQUIPMENT IDENTIFICATION

A. Provide data for each component of the system on Alberta Infrastructure Equipment Identification forms.

B. The Minister will supply one reproducible copy of forms requested by the Contractor for use on the project.

C. The Contractor shall produce all necessary equipment identification forms not included.

D. New forms shall contain information similar in nature to that contained in the Alberta Infrastructure forms.

E. The Minister will transform Consultant produced forms in the Department format and will provide one reproducible copy to the Contractor.

F. Equipment Identification forms are only required for Power Distribution System equipment.

1.10 MAINTENANCE SECTION

A. General:

1) Summarize data for this section from Contractor supplied maintenance submissions, supplemented by any additional appropriate data.
2) Include maintenance as a section of each system.
3) Organize data into sections, with divider tabs as follows:

    a. Maintenance Tasks and Schedules
    b. Spare Parts
    c. Suppliers and Contractors
    d. Tags and Directories
    e. Maintenance Brochures

B. Maintenance Tasks and Schedules:

1) Organize data according to system category, with further breakdown into individual systems as used in operations division of the manual. Provide section index and divider tabs for each system category. Summarize maintenance tasks from maintenance manufacturer's brochures, for each component of system in following format:

    a. Daily
    b. Weekly
    c. Monthly
    d. Semiannually
    e. Annually
    f. When required

C. Spare Parts List:

1) Organize data according to system category, with further breakdown into individual systems as used in operations division of manual. Provide section index and divider tabs for each system category. Summarize maintenance tasks from maintenance manufacturer's brochures, for each component of system.

D. Suppliers and Contractors List:

1) Provide summary of suppliers and contractors for each component of the system. List name, address and telephone number of each.

E. Tags and Directories:

1) Provide a copy of tags and directories as specified in Contract Documents.

F. Maintenance Brochures:

1) Include copies of all manufacturers' printed maintenance brochures pertaining to each product, equipment or system. Provide section index and divider tabs. Maximum of twenty-five sheets or one brochure per tab.

1.11 CONTRACT DOCUMENTATION AND STANDARDS SECTION

A. Coordinate collection of data required for this section.

B. Organize all data required by Construction Contract into sections, with divider tabs, as follows:

1) Drawing List
2) Shop Drawings and Product Data
3) Certificates
4) Warranties and Bonds
5) Reports
6) Standards Division

C. Drawing List: provide a list of all drawings required for performance of construction contract.

D. Shop Drawings and Product Data: provide final copies of all shop drawings and product data required by the Contract Documents. Include section index and divider tabs. Maximum of twenty-five sheets or one shop drawings per tab.

E. Certifications: provide copies of contractor certifications for the performance of the product and systems, and test reports verifying performance of products and systems. Include section index and divider tabs with maximum of twenty-five sheets or one report per tab. This should include, but not be limited to the following:

a. Electrical systems inspection.
b. Utility company inspection.
c. Occupational Health and Safety inspection.
d. Fire Alarm Verification certificate.

F. Warranties and Bonds: include one copy each of the Contractor's warranty, manufacturers' warranties longer than one year, bond, and any service contract provided by Contractor. Provide section index.

G. Reports: include copies of all reports relating to the testing, adjusting and balancing of equipment and systems, as required by the contract specification Sections 26 01 10 and 26 08 10. Include section index and divider tab for each report.

H. Standards Division: allow 25 mm binder space for standards.

PART 2 -- Products (NOT USED)

PART 3 -- Execution (NOT USED)

END OF SECTION

SECTION 26 01 26 – ELECTRICAL TESTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. This Section specifies the WORK necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.

B. The WORK of this Section includes furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein and functional testing of power and controls not tested under other Divisions, shall be completed before commencement of the 7 Day test of Section 01 75 00 - Equipment Testing and Startup. This scope may require the CONTRACTOR to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.

C. The requirements of Section 26 00 00 - Electrical Work, General, apply to the WORK of this Section.

D. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.

1.2 REFERENCES

A. General

1. The publications listed below form a part of this specification to the extent referenced.

2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

3. Use the latest adopted standard for references.

B. American National Standards Institute (ANSI)

C. UL (Underwriter’s Laboratories Inc.)

D. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

E. IEEE 576-2000, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications

F. InterNational Electrical Testing Association (NETA),

G. NFPA 70, National Electrical Code (NEC)

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 - Contractor Submittals.

B. Submit complete system test procedures for review. Test procedures shall include but not be limited to:

1. Detailed procedures in sufficient detail to verify conformance with these Specifications.

2. Incorporation of the Test Record Sheets included at the end of this Section.

3. Detailed comprehensive testing schedule including:

a. Each major piece of electrical distribution equipment.

b. Each major electrical subsystem.

c. Duration of each test.

d. Milestone test completion date.

e. Ambient Conditions at time of test

f. Date of test results submittals following completion of the tests.

g. Names and qualifications of the individual(s) responsible for performing the testing.

C. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the “as-left” settings of all devices, relays, circuit breakers, etc.

D. Test result shall be submitted in one submittal

E. Test reports shall be based on NETA’s latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA’s Acceptance Testing Specifications latest edition.

1.4 COMMISSIONING

A. Commissioning during the 7 Day test shall not be attempted until all subsystems have been found to operate satisfactorily. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable. Simulation of process parameters shall be considered only upon receipt of a written request by the CONTRACTOR.

B. Motor Current Tabulation

1. Main service phase voltage, phase amperage, total power and power factor data shall be recorded every 5 minutes during the commissioning.

2. Motors 5HP and larger which have current/power measurement capabilities shall have phase voltage, phase amperage, total power and power factor data recorded every 5 minutes while operating during commissioning.

PART 2 -- TESTING & REPORTS

2.1 PRE-ENERGIZATION AND OPERATING TESTS

A. The complete electrical system shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the protective device study and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

1. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.

2. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

3. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

B. Test Report. A test report covering the results of the tests required in the **Pre-Energization and Operating Tests** shall be delivered to the authority having jurisdiction prior to energization. Acceptance Testing shall be in accordance with NETA ATS-2009, *Electrical Power Distribution Equipment and Systems*, published by the InterNational Electrical Testing Association.

2.2 TEST REQUIREMENTS

A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.

1. Lighting: Switching, include remote control, if present in system. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.

2. Power Instrumentation: Demonstrate that voltage and ampere metering are functional and reading correctly.

3. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.

4. Low Voltage Cables-600 volts Maximum

a. Visual and Mechanical Inspection

1) Compare cable data with drawings and specifications.

2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.

3) Inspect bolted electrical connections for high resistance using one of the following methods:

a) Use of low-resistance ohmmeter.

b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS- 2009, Table 100.12.

4) Inspect compression-applied connectors for correct cable match and indentation.

5) Inspect for correct identification and arrangements.

6) Inspect cable jacket insulation and condition.

b. Electrical Tests

1) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.

a) Motor feeders tested with motors disconnected and controller open.

b) Motor control circuits tested and verified for proper operation with control stations and overcurrent devices connected.

c) Panelboard feeders tested with feeder breaker open and panel-board connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.

d) Conductors of main lighting feeders, including lighting panel with branch circuits open.

e) Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid state device.

f) Equipment which may be damaged during this test shall be disconnected.

g) The Engineer shall be consulted if minimum insulation values cannot be obtained.

2) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

3) Perform continuity test to insure correct cable connection.

c. Test Values – Visual and Mechanical

1) Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Bolt-torque levels should be in accordance with NETA ATS-2009, Table 100.12 unless otherwise specified by the manufacturer.

d. Test Values – Electrical

1) Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS-2009 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.

3) Cable shall exhibit continuity.

4) Deviations in resistance between parallel conductors shall be investigated.

5. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.

6. A functional test and check of electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:

a. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.

b. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels in accordance with the NEC.

c. Circuit Breakers

1) Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer.

2) Time and pickup setting shall correspond to the recommendations of the load equipment manufacturer's and Code.

3) Setting shall be tabulated and proven for each circuit breaker in its installed position.

4) Test results shall be certified by the person performing the tests and shall be submitted to the ENGINEER.

7. Complete ground testing of grounding electrodes per requirements below prior to operating the equipment.

B. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the ENGINEER and after process control devices have been adjusted as accurately as possible. Alarm conditions shall be simulated for each alarm point, and alarm indicators shall be checked for proper

operation. It is intended that the CONTRACTOR will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.

C. Metering and indication lights for motors and other devices shall be tested for proper operation.

D. All control circuits such as motor, interlock and remote shall be tested for proper operation.

E. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

F. Motor operated valves and gates shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve or gate manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.

G. All lighting panels, circuits and fixtures; and power panels, circuits and receptacles shall be tested for proper operation.

H. Provide ground resistance tests on the main grounding electrode or system in the presence of the ENGINEER and submit results

1. Visual and Mechanical Inspection

    a. Verify ground system is in compliance with drawings and specifications.

2. Electrical Tests

    a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

    b. The earth resistance of each ground electrode shall be measured and recorded before electrodes are connected to the grounding loop.

    c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values

    a. The resistance between the main grounding electrode and ground shall be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner.

    b. Investigate point-to-point resistance values which exceed 0.5 ohm.

I. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.

2.3 TEST REPORTS

A. The test report shall include the following:

1. Summary of project.
2. Description of equipment tested.
3. Description of test.
4. Test data.
5. Analysis and recommendations.

B. Test data records shall include the following minimum requirements:

1. Identification of the testing organization.
2. Equipment identification.
3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
4. Date of inspections, tests, maintenance, and/or calibrations.
5. Identification of the testing technician.
6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
7. Indication of expected results when calibrations are to be performed.
8. Indication of “as-found” and “as-left” results.
9. Sufficient spaces to allow all results and comments to be indicated.

C. The testing firm shall furnish a copy or copies of the complete report to the owner as required in the acceptance contract.

PART 3 -- TEST RECORD SHEETS

The test record sheets listed below shall be used to record testing of electrical equipment and of the electrical installation as required by these specifications. Sample copies of each sheet are attached.

Sheet No.	Title
1	Insulation Resistance (Power, Control Wire, and Cable) Test Record
2	Insulation Resistance (Instrument Wire and Cable) Test Record
4	Ground Electrode Testing Test Record
6	Bonding Resistance Readings (Nonelectrical Equipment/Structures) Test Record
7	Bonding Resistance Readings (Electrical Equipment) Test Record
8	Insulation Resistance (Transformer) Test Record
9	Insulation Resistance (Equipment) Test Record
10	Insulation Resistance (Rotating Equipment) Test Record
12	Record Feeder Breaker (480 VAC) Test Record
13	Breaker/Contactor (480 VAC) Test Record
14	460 VAC Motor Circuit Test Record
16	Electric Motor Run-In Test Record

INSULATION RESISTANCE
(POWER, CONTROL WIRE, AND CABLE)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

NOTES: 1. Perform Insulation Resistance Test (megger) between each conductor and all other conductors and metallic sheath for cables with nonshielded conductors. Test between each conductor and shield for multiconductor cables with shielded conductors. Record lowest reading for each cable.

2. Use 1,000-V test set for cable rated 600 volts and 2,500-V test set for cable rated over 600 volts.

3. Readings will vary inversely with temperature and cable length. When the use of temperature correction factors is specified, attach a second sheet with computed values. Indicate on each sheet “measured” or “temperature corrected.”

Panel No. Circuit No. Feeder No.	Wire Tagging	Cable Rated Voltage	Wire or Cable				Insulation Resistance (megohms) *	Initials
			Quantity	Size	From	To		

*Minimum acceptable values:

Cable Rated Voltage	Test Duration	Resistance for Cable Only	Cable/Wire Size or Amperage (megohms)	Resistance When Cable Connected to Equipment (ohms)

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE
(INSTRUMENT WIRE AND CABLE)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

NOTES: 1. Record only the lowest value.
2. MP - Multi-pair cable. SP - Single pair cable.
3. Megger with instruments disconnected.
4. Use 250 volt (or lower voltage, when specified) range on DC test set.
5. Readings will vary with temperature and cable length.*

Cable Number or Instrument Number	Indicate MP or SP Type (2)	Conductor to Conduit (Single Pair Non-Shielded Cables) (megohms)	Conductor to Conductor (megohms) (1)	Shield to Conductor to Shield (megohms) (1)	Overall Shield to Shield (Multipair Cables Only) (megohms) (1)	Lead and Armor (Multipair Cables Only (megohms)	Shield to Conduit (Single Pair Cables Only) (megohms)	Initials

DISTRIBUTION:

CONTRACTOR/Date _____

GROUND ELECTRODE TESTING
TEST RECORD

TEST EQUIPMENT: _____ _____
(Note 1) (Note 2)

REFERENCE DRAWING: _____ _____

NOTES: 1. Record resistance-to-earth for each electrode with all other conductors disconnected. Resistance not to exceed 25 ohms for any single anode.

2. Check continuity from each electrode to any test bar or other electrode such that the complete ground loop is tested.

Rod Number	Resistance to Earth (ohms)	Ambient Temperature (ºC/ºF)	Weather	Taps (□)	Initials/Date

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS
(NONELECTRICAL EQUIPMENT/STRUCTURES)
TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Vessels, tanks, and structural steel bonded to the main grounding system, dedicated ground rod or foundation, as indicated on drawings listed below.

2. Measure resistance from ground wire tap (or anchor bolt) to tagged equipment frame or structural steel.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS
(ELECTRICAL EQUIPMENT)
TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Electrical equipment bonded to the main grounding system or dedicated ground rod, as indicated on drawings listed below.

2. Measure resistance from ground wire tap to tagged equipment bus bars, tagged equipment enclosures, and any other points indicated on the drawings.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE
(TRANSFORMER)
TEST RECORD

SUBSTATION NO.: _____ TEST EQUIPMENT: _____

NOTES:
1. Use 1,000-V test set for 600-volt equipment and below, 2,500-V test set for equipment rated 601 - 5,000 volts, and 5,000-V test set for equipment rated over 5,000 volts.
2. Test voltage to be applied for 1-minute duration, and reading taken.
3. Neutral must be disconnected from ground during test.
4. Record temperature of surrounding air temperature for dry-type transformers.
5. Readings will vary inversely with temperature. When the use of temperature correction factors is specified, attach second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Equipment Tag No.	RESISTANCE IN (megahoms) *						Pri to Sec	Voltage Rating (kV)	Pri-Sec or Air	Liquid Temp. (ºC/ºF)
	Primary			Secondary						
	∅A to G	∅B to G	∅C to G	∅A to G	∅B to G	∅C to G				

*Minimum acceptable values:

VOLTAGE CLASS	RESISTANCE (megohms)

TESTER'S INITIALS/DATE _____

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE (EQUIPMENT)
TEST RECORD

TEST EQUIPMENT: _____ SUBSTATION: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

REFERENCE DRAWING: _____ REF. SEC.: _____

NOTES: 1. Use 1,000-V test set for equipment rated 600 volts and below, 2,500/5,000-V test set for equipment rated over 600 volts.

2. For equipment with solid state control circuits, consult manufacturer's literature for maximum test voltages.

Switchgear MCC (other)	INSULATION RESISTANCE (megohms) *						Test Voltage (kV)	Rated Voltage (kV)	Initials/ Date
	∅A to G	∅B to G	∅C to G	∅A to ∅B	∅B to ∅C	∅C to ∅A			

*Minimum acceptable values:

EQUIPMENT VOLTAGE CLASS (megohms)	RESISTANCE

TESTER'S INITIALS/DATE _____

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE (ROTATING EQUIPMENT)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

EQUIP. TEMP., IF KNOWN: _____ ºC _____ ºF HOW KNOWN: _____

NOTES:
1. Use 1,000-V test set for equipment 600-volt and below, 2,500/5,000-V test set for equipment rated over 600 volts.
2. Test duration shall be 1 minute, note if otherwise: _____.
3. Isolate all motor leads from one another and from frame, test phase separately, wherever practical.
4. Document testing of low voltage and medium voltage equipment on separate sheets.
5. Readings will vary inversely with temperature. When the use of temperature correction factors is specified, attach second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Equipment Tag No.	INSULATION RESISTANCE (megohms) *						Rated Voltage	Equipment Initial/Date
	∅A to G	∅B to G	∅C to G	∅A to ∅B	∅B to ∅C	∅C to ∅A		

*Minimum acceptable values:

VOLTAGE CLASS	RESISTANCE (megohms)

DISTRIBUTION:

CONTRACTOR/Date _____

FEEDER BREAKER (480 V MCC)
TEST RECORD

EQUIPMENT DESIGNATION		
LOAD (kW/kVA)	VOLTAGE	F.L.A.
CIRCUIT BREAKER MFG.	RATING	SETTING
CONDUCTOR SIZE	POWER	GROUND

1. Check nameplate data of breaker against approved vendor drawings. _____
2. Check breaker components for cleanliness. _____
3. Check mechanical function of breaker. _____
4. Check wiring for proper identification. _____
5. Check conduits/cables for tagging. _____
6. Check components for identification. _____
7. Check equipment for conformance of area classification. _____
8. Check installation for seals, breathers, and drains. _____
9. Verify power conductor continuity. _____
10. Check that power cable insulation resistance test (megger) is completed. _____

DISTRIBUTION:

CONTRACTOR/Date _____

BREAKER/CONTACTOR (480 V MCC)
TEST RECORD

EQUIPMENT DESIGNATION			
LOAD (kW/kVA)		VOLTAGE	F.L.A.
CIRCUIT BREAKER MFG.		RATING	SETTING
CONTACTOR MFG.		SIZE	
CONDUCTOR SIZE	POWER	CONTROL	GROUND

1. Check nameplate data of breaker, contactor fuses and relays against approved vendor drawings. _____
2. Check main and auxiliary contacts. _____
3. Check contactor/breaker components for cleanliness. _____
4. Check control fuses, CPT rating, and coil voltage. _____
5. Check mechanical function of contactor and breaker. _____
6. Check wiring for proper identification. _____
7. Check conduits/cables for tagging. _____
8. Check components for identification. _____
9. Check equipment for conformance to area classification. _____
10. Check installation for seals, breathers, and drains. _____
11. Verify continuity of all power and control leads. _____
12. Check that power and control cable Insulation Resistance Test (megger) is completed. _____
13. Complete functional operation check of the control circuit using contract drawings and approved vendor drawings. Close and open the contactor using all control devices. _____

DISTRIBUTION:

CONTRACTOR/Date _____

460 V MOTOR CIRCUIT (480 V MCC)
TEST RECORD

EQUIPMENT DESIGNATION			
MOTOR TAG NO.		VOLTAGE	F.L.A.
kW/HP		RPM	S.F.
CIRCUIT BREAKER MFG.		RATING	SETTING
STARTER MFG.		SIZE	O/L HTR. SIZE
C.T. RATIO		O/L RELAY SETTING	
CONDUCTOR SIZE	POWER	GROUND	

1. Check motor starter for cleanliness. _____

2. Check nameplate data and tagging of motor starter components for conformance to approved vendor drawings. _____

3. Check conduits and/or cables for correct tagging. _____

4. Check equipment and installation for conformance to area classification. _____

5. Check main and auxiliary contacts of breaker and contactors. _____

6. Manually check mechanical operation of breaker, contactor, O/L relay, and O/L reset device. _____

7. Check continuity of power and control cables. _____

8. Complete functional operation check of the motor control circuit using the contract drawings and approved vendor drawings. Close and open the starter using all control devices. _____

9. Verify proper operation of motor winding space heater unit. _____

DISTRIBUTION:

CONTRACTOR/Date _____

ELECTRIC MOTOR RUN-IN
TEST RECORD

TEST EQUIPMENT: _____ REFERENCE DRAWING: _____

NOTES: 1. Duration of tests to comply with specifications.

TEST	REMARKS	INITIALS/DATE
RESISTANCE: Bonding resistance measured from motor frame to main ground/earth system tap. _____ ohms		
VOLTAGE: Actual voltage measured at Motor Control Center. _____ volts		
ROTATION CHECK: Bump motor to verify rotation. Motor to be uncoupled.		
NO LOAD CURRENT: At beginning of test _____ amps At end of test _____ amps		
TEMPERATURE OF BEARING: Check bearing for high temperature: Before start: 15 minutes after start 30 minutes after start 1 hour after start 2 hours after start 3 hours after start		
VIBRATION: Make visual inspection during run-test. Record any unusual vibration in remarks column.		
NOISE: Record any unusual noise in remarks column.		

DISTRIBUTION:

CONTRACTOR/Date _____

- END OF SECTION –

SECTION 26 01 90 – ELECTRICAL SPARE PARTS AND MAINTENANCE MATERIALS

PART 1 -- GENERAL

1.1 RELATED SECTIONS

A. Section 01 78 43 - Spare Parts and Maintenance Materials:

1.2 INVENTORY LIST

A. Submit a complete inventory list of electrical spare parts and maintenance materials delivered to the Minister.

PART 2 -- PRODUCTS

2.1 SPARE PARTS AND MAINTENANCE MATERIALS SCHEDULE

Item	Description	Quantity
1	**Motor Control Centers**	
	HOA selector switch	2 of each type
	Pilot lights	12 of each color
	Control fuses	6, or 25% (min 1), of each size, whichever is smaller
	VFD control board	1
	VFD keyboard	1
	VFD cooling fan (120 V(ac))	1
	Thermostat	1
	Elapsed Time Meter	1
	Operating coil for each size starter	1
	Interposing relays(120 V(ac)), 4PDT, LED Indication	4
	Spare control terminals	50
	Push buttons	1 of each type
	Indicating lights	2 of each type of color
	Selector switches	1 of each type
	Potentiometer	1
2	**Transfer Switch (ATS-E1)**	
	Voltage Sensing Relays	2
3	**Luminaires/Emergency Lights**	
	LED fixtures (each type)	2
4	**Lamps**	
	LED arrays/lamps (each type)	2
5	**Fire alarm system**	
	Products of combustion detectors	2 of each
	Thermal detectors	2 of each type
	Pullstations	1 of each type
	Notification appliances	1 of each type

2.2 TOOLS AND CABINETS

A. Provide all special tools required for normal maintenance in a heavy gauge, corrosion resistant metal box complete with lock and keys.

B. Provide wall mounted metal cabinet with adjustable shelving and hinged locking door to house all spare parts associated with power system.

PART 3 -- EXECUTION

3.1 DELIVERY

A. Deliver spare parts and maintenance materials to project site or other location designated by the Province and obtain receipt for materials delivered.

END OF SECTION

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Work under this Contract generally consists of supply, installation and putting into operation the electrical systems as indicated on the drawings and specified herein and common work results as outlined below.

B. All material supplied and installed under this contract shall be rated for the area of install, and it shall have a minimum life expectancy of 18 years. In case the material specified does not comply with this requirement, Contractor shall submit an alternate material and price as an add-on to the base bid price.

C. The support steel system necessary for electrical equipment, conduit, cables and devices shall be part of the Contractor's scope. All concrete work associated with this install shall be coordinated with Division 03.

D. The Contractor shall review and understand the design and construction for the installation of electrical distribution systems and associated equipment for the new Electrical systems installations at the Battle Creek Fish Hatchery (BCFH).

E. The Contractor is responsible for the testing and commissioning of the entire electrical installations under this Contract.

F. All equipment within replaced MCCs that are connected into the facility BMS / control system, including but not limited to starters, drives, transfer switches, monitoring relays, and power monitoring equipment, shall have all control signals and wiring re-terminated to the replaced equipment to maintain existing control scheme and functionality of the equipment. Verify all controls connections to equipment prior to removing equipment to confirm reconnection requirements.

G. The Contractor shall be responsible for the completion and submission of an Arc Flash Incident Energy Analysis Report for the entirety of the Battle Creek Fish Hatchery in order to determine requirements for workplace safety to help identify and prevent injury to personnel from equipment shock and arc flash hazards. The Work shall include an NSPE licensed professional authenticated report including items as identified in IEEE 1584.1 "IEEE Guide for the Specification of Scope and Deliverable Requirements for an Arc Flash Hazard Calculation Study in Accordance with IEEE Std 1584. The report shall include, but not be limited to:

1. An NSPE licensed professional authenticated cover page

2. Executive Summary

3. Scope of Study and Results Summary

4. Background Information used such as available utility fault current and X/R ratios, Utility transformer construction and performance data, cable sizes, types and lengths of cables, software used, configuration settings, and assumptions made. Include copy of facility Single Line Diagrams in an Appendix and ensure labelling between software and Single

Line Diagrams are compatible. Include all digital backup files, custom files, and any custom library files with the report. Provide copy of the finalized report and all above identified files on a USB flash drive.

5. Short circuit analysis listing all equipment and verifying that equipment is properly rated for the available short circuit rating.

6. Coordination study including results and recommendations. Include all time-current characteristics curves used. Include potential changes to lower incident energy levels for review by the Consultant and Province.

7. Arc Flash Incident Energy Analysis. Include a spreadsheet listing all equipment. Include recommendations for incident energy reduction.

8. Provide sample Arc Flash and Shock Hazard labels for facility.

   a. Arc Flash and Shock Hazard labels shall be provided on all distribution equipment per the results of the Arc Flash Incident Energy Analysis Report.

9. Conclusion / Recommendations.

H. Work shall be performed in accordance with the attached drawings and specification and shall include but not be limited to the following:

1. New Electrical systems installation for the BCFH.

1.2 RELATED REQUIREMENTS

A. Division 01 - General Requirements

B. Division 27 - Communications

C. Division 28 - Fire Alarm

1.3 REFERENCE STANDARDS

A. NEC, National Electrical Code

B. UL, Underwriter's Laboratories Inc.

C. SPEC NOTE: The following reference standard IEEE SP1122, replaces former IEEE Std 100

D. Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)

E. IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition

1.4 DEFINITIONS

A. Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.5 PRODUCT DATA

A. Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

1.6 SHOP DRAWINGS

A. Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.

B. Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

C. Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

D. Submit drawings in accordance with 01 33 23 – Shop Drawings, Product Data and Samples.

E. If changes are required, notify the Consultant of these changes before they are made.

1.7 CERTIFICATES

A. Provide UL / American certified equipment and material.

B. Submit test results of installed electrical systems and instrumentation.

C. Permits and fees: in accordance with General Conditions of Contract.

D. Submit, upon completion of Work, load balance report as described in clause 3.13 FIELD QUALITY CONTROL – Load Balance.

E. Submit certificate of acceptance from authority having jurisdiction upon completion of Work to the Consultant.

F. Manufacturer's Field Reports: submit to the Consultant the manufacturer’s written report, within three (3) days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in clause 3.13 – FIELD QUALITY CONTROL

1.8 SUBMITTALS

A. Submit in accordance with 01 33 00 – Contractor Submittals

B. Operation and Maintenance Data: submit operation and maintenance data for incorporation into the Operations and Maintenance manual.

C. Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

D. Operating instructions to include following:

1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment

2. Start up, proper adjustment, operating, lubrication, and shutdown procedures

3. Safety precautions

4. Procedures to be followed in event of equipment failure

5. Other items of instruction as recommended by manufacturer of each system or item of equipment

E. Print or engrave operating instructions and frame under glass or in approved laminated plastic

F. Post instructions where directed

G. For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures

H. Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in accordance with the manufacturer's written instructions

B. Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address

C. Storage and Handling Requirements

1. Store materials indoors, in dry location, off ground, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area

2. Store and protect products from nicks, scratches, and blemishes

3. Replace defective or damaged materials with new

1.10 DRAWINGS AND SPECIFICATIONS

A. Drawing use and interpretation:

1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically, dimensioned, or detailed

2. For exact locations of structural elements, refer to dimensioned structural drawings

3. Field measurements take precedence over dimensioned drawings

4. Intention is to show size, capacity, approximate location, direction, and general relationship of one work phase to another, but not exact detail or arrangement

5. Field-verify locations and arrangement of all existing systems and equipment

6. Dimensions indicated anywhere are limiting dimensions

B. Installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings

C. Do not use equipment exceeding dimensions indicated or equipment or arrangements that reduce required clearances or exceed specified maximum dimensions

D. Furnish and install all materials to provide functioning systems in compliance with performance requirements specified, and any modifications resulting from reviewed shop drawings and field coordinated drawings

1.11 CODES, PERMITS, AND FEES

A. The installation shall comply with the requirements of the current edition of the National Electrical Code and the Electrical by-laws of the local Electrical Authority

B. Other codes or standards which apply are:

1.	IEEE	International Electronic and Electrical Engineering Society
2.	IES	Illumination Engineering Society
3.	EEMAC	Electrical Equipment Manufacturers Association of Canada
4.	NEMA	National Electrical Manufacturers Association
5.	ANSI	American National Standards Institute
6.	NBC	National Building Code
7.	UL	Underwriters Laboratory
8.	ULC	Underwriters Laboratory Canada
9.	FMC	Factory Mutual Canada
10.	NFPA	National Fire Protection Agency

C. Obtain all permits required and, after completion of the Work, furnish to the Consultant the certificate of final inspection and approval from the local Inspection Authority. Take out all permits at the beginning of the Work.

D. Submit a set of electrical drawings to the local Inspection Authority under whose jurisdiction this comes within two (2) weeks from date Contract was awarded.

E. In the event that this is not done, and the local Inspection Authority requires some changes, the changes shall be made at no expense to the Province.

F. Obtain the required construction permits, arrange for inspections and supply the Consultant with certificate of final inspection and approval.

G. Electrical plans and specifications shall be submitted to the electrical inspection department by the Contractor for approval. The Contractor shall forward a copy of the letter and drawings to the Consultant.

1.12 ELECTRICAL EQUIPMENT APPROVAL

A. All new electrical equipment or systems must be certified by a certification body recognized by the Standards Council of America.

B. Equipment not having certification shall have special inspection label and be inspected, tested, and accepted by a certification body and the equipment bears evidence of having been accepted by the authorized certification body.

1.13 PROTECTION

A. Provide covering and shielding for all equipment provided to protect from damage.

B. Protect nameplates on equipment to prevent defacing.

C. Repair, restore or replace damaged, corroded, and rejected items.

1.14 JOB CONDITIONS

A. Schedule Work which will cause interference or interruption in advance with the Consultant, authorities having jurisdiction, and all affected trades.

B. Examine Contract Documents to determine how other Work will affect the execution of electrical Work.

C. Where any material, equipment or system components are installed differently from that shown, show such differences clearly and neatly, using ink or indelible pencil.

D. At project completion, submit the record set of drawings to the Consultant.

PART 2 -- PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Operating voltages: to the National Electrical Code.

B. Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

C. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

D. Language operating requirements: provide identification labels and nameplates for control items in English.

2.2 SETTING OUT OF WORK

A. Where equipment is built-in with Work of other trades, supply equipment to be built-in or measurements to allow necessary openings to be made so as not to hold up Work.

B. Make reference to electrical, mechanical, structural, process, and architectural drawings when setting out Work. Consult with respective Divisions in setting out locations for conduit runs, luminaires, panel assemblies, etc., so that conflicts are avoided, equipment is operable and serviceable, and symmetrical even spacing is maintained.

C. Layouts shown for mechanical and electrical rooms are for estimating purposes only. Coordinate installation of conduit, outlets and equipment with final room equipment layout.

D. Where switches, receptacles, and fire alarm break glass stations are in the same general location, outlets to be lined up vertically unless otherwise called for by the Consultant.

2.3 MATERIALS AND EQUIPMENT

A. Provide material and equipment in accordance with Section 01 62 00 – Product Options and Substitutions.

B. Equipment and Material to be UL/ American certified.

C. Factory assemble control panels and component assemblies.

D. Use only prime quality, new materials, apparatus and equipment.

E. All electrical equipment must be certified by a recognized certification agency adopted by the Standards Council of America. Equipment not having certification shall not be connected by Contractor unless application is made to a recognized certification agency for Special Inspection / Special Acceptance and the Consultant has approved the equipment to be installed. Refer to clause 1.11 – CODES, PERMITS, AND FEES and clause 1.12 – ELECTRICAL EQUIPMENT APPROVAL above for acceptable certifications.

F. Structural steel for supports: ASTM A36.

G. Galvanized members installed in all areas.

H. Shop fabricate for field assemble using bolts.

I. Minimize field welding.

J. Repair damaged galvanized surfaces with a “cold-galv” type paint.

2.4 ACCEPTABLE MANUFACTURERS

A. As indicated for individual items.

B. Alternate material of superior or equal quality will be considered after contract award if quoted in Tender as a change to the base bid price. The specified item(s) shall be carried as the base bid.

2.5 ELECTRIC MOTORS, EQUIPMENT, AND CONTROLS

A. Verify installation and co-ordination responsibilities related to motors, equipment, and controls, as indicated.

2.6 WARNING SIGNS

A. Warning Signs: in accordance with requirements of the inspection authorities and the authority having jurisdiction.

B. Porcelain enamel decal signs, minimum size 175 x 250 mm.

2.7 WIRING TERMINATIONS

A. Ensure lugs, terminals, screws used for termination of wiring are suitable for copper conductors.

2.8 ARC FLASH HAZARD WARNING LABELS

A. Arc Flash and Shock Hazard labels shall be provided on all distribution equipment per the results of the Arc Flash Incident Energy Analysis Report.

2.9 EQUIPMENT IDENTIFICATION

A. Identify electrical equipment with labels or nameplates as follows:

1. Nameplates: lamicoid plastic laminate mm (melamine) complete with thick plastic engraving sheet, matt white finish, black face, white core, lettering accurately aligned and engraved into core, mechanically attached with self tapping screws.

2. Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

B. Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

C. Wording on nameplates or labels to be approved by the Consultant.

D. Allow for minimum of twenty-five (25) letters per label or nameplate.

E. Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

F. Disconnects, starters and contactors: indicate equipment being controlled and voltage.

G. Terminal cabinets and pull boxes: indicate system and voltage.

H. Transformers: Indicate capacity, primary and secondary voltages.

2.10 WIRING INDENTIFICATIONS

A. Identify wiring with permanent indelible identifying markings, numbered or by use of colored plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

B. Maintain phase sequence and color coding throughout.

C. Color coding: to National Electrical Code.

D. Use color coded wires in communication cables, matched throughout system.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

B. Visually inspect substrate in presence of the Consultant.

C. Inform Consultant of unacceptable conditions immediately upon discovery.

D. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Consultant.

3.2 INSTALLATION

A. Do complete installation in accordance with the NEC except where specified otherwise.

B. Do overhead and underground systems in accordance with the NEC except where specified otherwise.

3.3 MECHANCIAL AND PROCESS EQUIPMENT WIRING - POWER

A. Provide all labour and materials required to complete electrical power wiring for pumping, plumbing, heating and ventilating equipment as called for in these specifications and/or shown on the drawings.

B. Provide all single and three phase motor protection switches, combination starters, disconnects, and lock out control switches as required for mechanical and process equipment unless otherwise specifically noted in these specifications or on the drawings.

C. Provide all power cables and raceways to vendor packages as outlined in the detailed design Drawings.

D. Provide Variable Frequency Drives (VFDs) and related equipment for pumps.

E. All mechanical ventilation equipment VFDs and disconnect switches supplied by Division 23 but electrical wiring to this equipment shall be by electrical contractor.

F. Supply and installation of motors for mechanical and process equipment is specified in Division 23, Division 40, and Division 46.

3.4 WIRING - CONTROL

A. All control conduit and wiring unless specifically noted otherwise for motors and mechanical equipment is specified in Division 23, Division 40, and Division 46.

B. All control components and control connections from control terminal sections of motor control centers to automatic devices, interlocking, etc., is specified in Division 23, Division 40, and Division 46.

3.5 MECHANICAL EQUIPMENT WIRING

A. All HVAC control conduit and wiring, unless specifically noted otherwise for fans, dampers and unit heaters, shall be the responsibility of Division 23.

B. All HVAC control components and control connections from control terminal sections of motor control centers to automatic devices, interlocking, etc., shall be the responsibility of Division 23.

C. Motors for HVAC mechanical equipment shall be supplied and set-in place by Division 23.

3.6 FIRESTOPS EQUIPMENT WIRING

A. Refer to Division 07 for installation of firestops and smoke seals around conduit and cable which penetrate ULC rated fire separations. This Work is to be performed by the trade responsible for installing firestops and smoke seals around and within ULC rated fire separations to maintain their integrity.

3.7 NAMEPLATES AND LABELS

A. Ensure manufacturer's nameplates, UL labels and identification nameplates are visible and legible after equipment is installed.

B. Arc Flash Hazard labels shall be installed in coordination with the Arc Flash Incident Energy Analysis Report on all pertinent equipment at clearly visible locations.

3.8 CONDUIT AND CABLE INSTALLATION

A. Install conduit and sleeves prior to pouring of concrete.

B. Sleeves through concrete: plastic or schedule 40 steel pipe or sheet metal, sized for free passage of conduit, and protruding 50 mm.

C. If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

D. Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.9 LOCATION OF OUTLETS

A. Locate outlets in accordance with the detailed drawings and specifications.

B. Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

C. Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.

D. Locate light switches on latch side of doors.

3.10 MOUNTING HEIGHTS

A. Mounting height of equipment is from finished floor to centerline of equipment unless specified or indicated otherwise.

B. If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

C. Install electrical equipment at following heights unless indicated otherwise.

1. Local switches: 1400 mm.

2. Wall receptacles: 1400 mm.

3. In mechanical or process areas: 1400 mm.

4. Panelboards: as required by Code or as indicated.

5. Wall mounted telephone and interphone outlets: 1500 mm.

6. Disconnects: 1500 mm

D. Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.11 CUTTING AND PATCHING

A. In order to avoid cutting, sleeves or frames shall be cast into concrete sections.

B. Provide all necessary anchoring devices and supports.

C. Use structural supports suitable for equipment, or as indicated.

D. Check loading and dimensions of equipment with shop drawings.

E. Do not cut or weld to bridge structural members.

F. Verify that equipment will fit support layouts indicated.

G. Where substitute equipment is used, revise indicated supports to fit.

H. Arrange for necessary openings to allow for admittance of equipment.

I. Where equipment cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, or other devices to allow later installation.

J. Install equipment to permit easy access for normal maintenance.

K. Maintain easy access to switches, motors, drives, pull boxes, receptacles, etc.

L. Relocate items which interfere with access.

3.12 FIELD QUALITY CONTROL

A. Load Balance:

1. Measure phase current to panel boards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

2. Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

3. Provide upon completion of work, load balance report. Report on phase and neutral currents on panelboards, dry-core transformers and motor control centers, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

B. Conduct following tests in accordance with Section 01 45 00 - Quality Control.

1. Power distribution and power generation system including phasing, voltage, grounding and load balancing.

2. Circuits originating from branch distribution panels.

3. Lighting and its control.

4. Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

5. Insulation resistance testing:

a. Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

b. Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

c. Check resistance to ground before energizing.

6. Carry out tests in presence of Consultant and if required, inspectors of agencies having jurisdiction.

7. Contractor shall furnish or arrange for the use of electrical energy or fuel required for the test(s).

8. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.13 SYSTEM STARTUP

A. Instruct Province in operation, care and maintenance of systems, system equipment and components.

B. Arrange and pay for services of manufacturer's factory service Consultant to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

1. Prepackaged systems

2. Motor Control Centers (MCCs)

3. Automatic Transfer Switch (ATS)

4. Manual Generator Transfer Switch

5. Neutral Grounding Resistance (NGR) system

6. Active Harmonic Filtering (AHF) system

7. Variable Frequency Drives (VFDs)

C. Provide these services for such period, and for as many visits as necessary to put equipment in operation and ensure that operating personnel are conversant with aspects of its care and operation.

3.14 CLEANING

A. Progress Cleaning: clean in accordance with Section 01 74 23 – Final Cleaning.

B. Leave Work area clean at end of each day.

C. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 23 - Cleaning.

D. Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

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SECTION 26 05 10 - ELECTRIC MOTORS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. **General:** The CONTRACTOR shall provide electric motors, accessories, and appurtenances complete and operable, in conformance to the Contract Documents.

B. The provisions of this Section apply to low voltage 3 phase, AC squirrel cage induction motors throughout the Contract Documents, except as indicated otherwise.

C. The CONTRACTOR shall assign to the equipment supplier the responsibility to select suitable electric motors for the equipment. The choice of motor manufacturer shall be subject to review by the ENGINEER. Such review will consider future availability of replacement parts and compatibility with driven equipment

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Complete motor data shall be submitted with the driven machinery Shop Drawings. Motor data shall include:

1. Machine name and specification number of driven machine.
2. Motor manufacturer.
3. Motor type or model and dimension drawing. Include motor weight.
4. Nominal horsepower.
5. NEMA design.
6. Enclosure.
7. Frame size.
8. Winding insulation class and temperature rise class.
9. Voltage, phase, and frequency ratings.
10. Service factor.
11. Full load current at rated horsepower for application voltage.
12. Full load speed.
13. Guaranteed minimum full load efficiency. Also nominal efficiencies at 1/2 and 3/4 load.
14. Type of thermal protection or overtemperature protection, if included
15. Wiring diagram for devices such as motor leak detection, temperature, or zero speed switches, as applicable
16. Bearing data. Include recommendation for lubricants of relubricatable type bearings.

17. If utilized with a variable frequency controller, verify motor is inverter duty type. Include minimum speed at which motor may be operated for the driven machinery. Provide shaft grounding details and information.
18. Power factor at 1/2, 3/4 and full load.
19. Information on all accessories provided.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Electric motors driving identical machines shall be identical.

B. Maximum motor loading shall be equal to nameplate horsepower rating or less, exclusive of service factor and be verifiable from the submittal data of the driven machinery.

C. Motor Capacity

1. The CONTRACTOR shall size motors for the larger of the following criteria:

a. Size motors to continuously carry the maximum load that develops across the full range of driven equipment operation.

b. Size motors for minimum size indicated

2. In every case, motor size shall be derated from nameplate values as follows:

a. Ambient Temperature

1) For ambient temperatures up to but not exceeding 40 degrees C, no derating is required.

2) For ambient temperatures exceeding 40 degrees but less than 50 degrees C, derate nameplate HP ratings to 85 percent.

b. Site Altitude: No derating is required for altitudes less than 3300 feet (1000 meters). Higher altitudes require the following derating factors:

Altitude	1.0 Service Factor	1.15 Service Factor
3300 to 9000 ft	93 percent	100 percent
9000 to 13,200 ft	91 percent	98 percent

3. Increased circuit breaker, magnetic starter, and conductor and conduit capacities required for motors larger than the indicated sizes shall be provided as part of the WORK.

D. **Exempt Motors:** Motors for valve and gate operators, submersible pumps, or motors which are an integral part of standard manufactured equipment, i.e., non-NEMA mounting, common shaft with driven element, or part of domestic or commercial use apparatus may be excepted from these requirements to the extent that such variation reflects a necessary condition of motor service or a requirement of the driven equipment.

2.2 DESIGN REQUIREMENTS

A. **General:** Electric motors shall comply with NEMA MG-1 - Motor and Generator. Motors used with adjustable frequency drives shall comply with NEMA MG-1, Part 31, and shall be clearly identified as "Inverter Duty."

B. **NEMA Design:** Electric motors shall be NEMA Design B unless otherwise indicated. In no case shall starting torque or breakdown torque be less than the value in NEMA MG 1. Motors shall be suitable for the indicated starting method.

C. **Motor Voltage Ratings:** Low voltage motors shall have voltage ratings in accordance with the following, unless otherwise indicated:

1. Motors below 1/2 HP shall be rated 115 volts, single phase, 60 Hz. Dual voltage motors rated 115/230 volts, 115/208 volts, or 120-240 volts are acceptable, provided leads are brought out to the conduit box.

2. Motors 1/2 HP and larger shall be rated 460 volts, 3 phase, 60 Hz. Dual voltage motors rated 230/460 volts or 208/230/460 volts are acceptable, provided every lead is brought out to the conduit box.

D. **Insulation:** Three phase motors shall be provided with Class F insulation, rated to operate at a maximum ambient temperature of 40 degrees C and at the altitudes where the motors will be installed and operated, without exceeding Class B temperature rise limits stated in NEMA MG 1-12.44. Single phase motors shall have Class F insulation with temperature rise not to exceed the insulation class. Motors to be operated from adjustable frequency drives shall be provided with insulation systems to withstand 1600 volt spikes, with dV/dT as defined in NEMA MG 1-31. The adjustable frequency drive manufacturer shall coordinate with the motor manufacturer to determine when additional dV/dT protection is required. Where required, it shall be furnished and installed as per the manufacturer's written instructions.

E. Motors 50 HP or smaller shall be totally enclosed, fan cooled (TEFC) with a Service Factor of 1.15 unless otherwise indicated.

F. Motors 50 HP and greater TEFC, with a service factor of 1.15.

G. Motors larger than 1/2 HP installed outdoors shall be provided with 120 volt AC space heaters, wired to a terminal strip in a low voltage motor junction box. If provided by the manufacturer when not specified, the CONTRACTOR shall connect them at no extra cost to the OWNER, in order to keep the warranty in force.

H. NEMA Premium Efficiency Motors

1. Motors with a nameplate rating of 1 HP and larger shall be NEMA premium efficient units. Motors shall be stamped with the efficiency on the nameplate with the caption "NEMA Nominal Efficiency" or "NEMA Nom. Eff." Such motors shall have efficiencies determined by the test as set forth in ANSI/IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators, Method B.

2. Efficiency: Nominal efficiency and minimum efficiency shall be defined in accordance with the following tables. Both efficiencies shall be included in the Shop Drawing submittal.

TOTALLY ENCLOSED - FAN COOLED (TEFC)						
FULL-LOAD EFFICIENCIES OF NEMA PREMIUM EFFICIENCY MOTORS RATED 600 VOLTS OR LESS						
	2 POLE		4 POLE		6 POLE	
HP	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.	Nom. Effic.	Min. Effic.
1	77.0	74.0	85.5	82.5	82.5	80.0
1.5	84.0	81.5	86.5	84.0	87.5	85.5
2	85.5	82.5	86.5	84.0	88.5	86.5
3	86.5	84.0	89.5	87.5	89.5	87.5
5	88.5	86.5	89.5	87.5	89.5	87.5
7.5	89.5	87.5	91.7	90.2	91.0	89.5
10	90.2	88.5	91.7	90.2	91.0	89.5
15	91.0	89.5	92.4	91.0	91.7	90.2
20	91.0	89.5	93.0	91.7	91.7	90.2
25	91.7	90.2	93.6	92.4	93.0	91.7
30	91.7	90.2	93.6	92.4	93.0	91.7
40	92.4	91.0	94.1	93.0	94.1	93.0
50	93.0	91.7	94.5	93.6	94.1	93.0
60	93.6	92.4	95.0	94.1	94.5	93.6
75	93.6	92.4	95.4	94.5	94.5	93.6
100	94.1	93.0	95.4	94.5	95.0	94.1
125	95.0	94.1	95.4	94.5	95.0	94.1
150	95.0	94.1	95.8	95.0	95.8	95.0
200	95.4	94.5	96.2	95.4	95.8	95.0
250	95.8	95.0	96.2	95.4	95.8	95.0
300	95.8	95.0	96.2	95.4	95.8	95.0
350	95.8	95.0	96.2	95.4	95.8	95.0
400	95.8	95.0	96.2	95.4	--	--
450	95.8	95.0	96.2	95.4	--	--
500	95.8	95.0	96.2	95.4	--	--

Source: NEMA MG1 - 2011, Table 12-12

2.3 ACCESSORY REQUIREMENTS

A. **General:** Horizontal motors 3 HP and larger and every vertical motor shall have split-type cast metal conduit boxes. Motors shall be provided with oversized conduit boxes. Motors other than open drip-proof shall be gasketed.

B. **Lifting Devices:** Motors weighing 265 lb (120 Kg) or more shall have suitable lifting eyes for installation and removal.

C. **Special Requirements:** The CONTRACTOR shall refer to individual equipment specifications for special requirements such as motor winding thermal protection or multi-speed windings.

D. **Grounding Lugs:** Provide motor grounding lug suitable to terminate ground wire, sized as indicated.

E. **Nameplate:** Motors shall be fitted with permanent stainless steel nameplates indelibly stamped or engraved with NEMA Standard motor data, in conformance with NEMA MG-1-10.40. Inverter duty motors shall be clearly identified as such.

F. Where motors are indicated by elementary schematics or specifications to have accessories, the accessories shall be factory mounted integral to the motors.

G. Inverter duty motors shall be provided with shaft grounding rings. Rings shall be factory installed, and shall be by **Aegis**, or equal. The motor warranty shall include coverage against VFD-induced bearing damage or failure. Inverter duty motors shall be provided with insulated bearing(s) when recommended by the motor manufacturer.

2.4 MOTOR THERMAL PROTECTION

A. **Single Phase Motors:** Single phase 120, 208 volt motors shall have integral thermal overload protection or shall be inherently current limited.

B. **Thermostats:** Where indicated or specified, winding thermostats shall be snap action, bi-metallic, temperature-actuated switch. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be precalibrated by the manufacturer. All inverter duty motors shall be provided with winding thermostats.

2.5 MOTOR BEARINGS

A. **General:** Bearings shall conform to Section 46 01 00 - Equipment General Provisions, except as indicated herein.

B. Motors greater than 2 HP shall have bearings designed for 17,500 hours (belted) or 100,000 hours (coupled) L-10 life.

C. **Fractional Horsepower:** Motors with fractional horsepower through 2 HP shall be provided with lubricated-for-life ball bearings.

D. **Horizontal Motors Over 2 HP:** Motors larger than 2 HP shall be provided with relubricatable ball bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

E. **Vertical Motors Over 2 HP:** Vertical motors larger than 2 HP shall be provided with relubricatable ball, spherical, roller, or plate type thrust bearings. Lubrication shall be per manufacturer's recommendation for smooth operation and long life of the bearings.

F. **Inverter Duty Motors:** Provide an insulated bearing to prevent circulating bearing currents.

2.6 MANUFACTURERS, OR EQUAL

A. **U.S. Motors**

B. **General Electric**

C. **WEG**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Motor installation shall be performed in accordance with the motor manufacturer's written recommendations and the written requirements of the manufacturer of the driven equipment. Shaft grounding devices shall be connected to the grounding system in accordance with the manufacturer's recommendations.

B. Related electrical WORK involving connections, controls, switches, and disconnects shall be performed in accordance with the applicable sections of Division 26.

3.2 FACTORY TESTING – NOT USED

3.3 FIELD TESTING

A. The CONTRACTOR shall perform the following field tests:

1. Inspect each motor installation for any deviation from rated voltage, phase, frequency, and improper installation.

2. Visually check for proper phase and ground connections. Verify that multi-voltage motors are connected for proper voltage. Verify shaft grounding devices are properly grounded.

3. Check winding and bearing temperature detectors and space heaters for functional operation.

4. Test for proper rotation prior to connection to the driven equipment.

5. Visually check that motor overload heaters are properly sized and that MCP breaker settings are correct for the motor installed.

6. Test insulation (megger test) of new and re-used motors in accordance with NEMA MG-1. Test voltage shall be 1,000 VAC plus twice the rated voltage of the motor.

END OF SECTION

SECTION 26 05 15 – INDUSTRIAL CONTROL PANELS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. CONTROL PANELS:

1. LCP-300
2. LCP-400
3. LCP-600
4. MCP-01

B. The CONTRACTOR shall provide complete industrial control panels and/or local control stations as indicated herein or in other Sections of the Specifications. The stations shall be designed to provide the sequence of operation in Contract Documents.

C. This section also specifies miscellaneous electrical devices used throughout this project. These devices are not limited to use within industrial control panels or local control stations.

D. Responsibility shall include the supply, fabrication, checkout, layout, documentation, delivery, and installation on site, fully equipped and functional control panels as shown on the panel design drawings and as specified herein.

E. Responsibility shall include supply and installation of all components and vendor subsystems so as to provide functioning control panel(s).

F. Component subsystems shall include, but not be limited to:

1. Programmable Logic Controller (PLC);
2. Panel lighting;
3. Panel wiring and grounding;
4. Breakers and power requirement, including power supplies, surge protection device, Uninterruptible Power Supply, and power distribution equipment such fuses, terminals, and interposing relays; and
5. Communications requirements

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Industrial control panels and/or local control stations shall comply with THE SUMMARYs of NEC (including Article 409), NEMA, and UL.

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings in accordance with Sections 01 33 00 – Contractor Submittals and 26 00 00 – Electrical Work, General.

1. Schematic “ladder” diagrams and written descriptions explaining ladder diagram operation and system operation. Schematic diagrams shall identify external connections between the control panel/control panel devices and associated “field” equipment. These diagrams shall show interconnecting wiring by dashed lines, and designate terminal assignments. If the termination information for field devices is not known at the time of the submittals then underscores shall be shown on the drawings to draw attention to the missing information, and a revised set of drawings shall be shipped with the control panel to the project site with the missing information to allow CONTRACTOR terminations.

2. Shop drawings shall show conformance to the wiring and installation requirements of Part 3 of this Section.

3. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.

4. A bill of material which enumerates devices associated with the control panel.

5. Include catalog cuts of control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

6. A listing of spare parts to be furnished.

B. Furnish written control panel operating procedures for normal such as startup, shutdown and abnormal operating conditions such as placing the equipment in a safe condition or resetting after an alarm or shut down triggered by equipment safeties, etc. In addition to the copies provided in accordance with Sections 01 33 00 - Contractor Submittals and 26 00 00 – Electrical Work, General provide one laminated copy with each control panel specific to that control panel.

C. Documentation shall include:

1. Equipment descriptive data;

2. Equipment installation, service manuals, operation/maintenance manuals;

3. Recommended spare parts lists;

4. Conductor identification, field terminals, changes, etc. on the schematic drawings;

5. As-built information for the completed control panel(s);

6. Copy of Panel Inspection Check Sheet(s), FAT sheet(s);

7. List of IP addresses; and

8. Certification in the form a CSA label on each control panel, certifying the panel as an entity.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall provide the equipment, panels and stations to satisfy the functional requirements in the relevant mechanical equipment and Instrumentation and Control specifications and the Electrical Elementary Schematics. Each panel and station shall be fabricated with UL labeled components. Equipment not specifically indicated as being WORK of other Sections shall be provided under this Section. All equipment, panels and stations shall be wired under this Section.

B. The controls shall be 120 volt maximum. Where the electrical power supply is 208 volt or 480 volt the station shall be provided with a fused control power transformer. One lead on the secondary side shall be grounded except where specifically indicated otherwise. Control conductors shall be provided in accordance with Section 26 05 19 – Wire and Cabling.

C. Each panel and/or station shall be provided with identified terminal strips for the connection of external conductors. The CONTRACTOR shall provide sufficient terminal blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with Shop Drawings. The panels and/or stations shall be the source of power for all controlled devices interconnected with the panels and/or stations. Equipment associated with the panels and/or stations shall be ready for service after connection of conductors to equipment, controls, panels and/or stations.

D. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

E. This specification covers the minimum requirements for the shop fabrication and testing of control panel(s) as described herein.

F. All components contained on or within the panels are to be supplied and fully wired under this Contract.

G. The selection of all accessories, materials and methods for fabrication not specifically covered by this specification, but which are necessary to complete the fabrication of the control panels, shall be the responsibility of the panel fabricator and shall be carried out in accordance with good engineering practices.

H. The control panels shall be fabricated to the applicable codes and standards as follows:

1. National Electrical Manufacturers Association (NEMA).

2. Underwriters Laboratory (UL).

3. Institute of Electronic and Electric Engineers (IEEE).

I. Wiring for control signals shall be a minimum of #16 AWG TEW105 tinned stranded copper; insulation rated at 300 Volt (minimum) unless otherwise specified.

J. Wiring for AC power distribution shall be a minimum of #14 AWG TEW105 tinned stranded copper; insulation rated at 300 Volt (minimum) unless otherwise specified.

K. Each wire must be tagged at both ends with a heat shrink sleeve that is machine printed or approved alternate.

L. Wiring systems with different voltage levels or types must be suitably segregated within the panel were applicable.

M. All wiring shall be run in enclosed plastic wireways such as Panduit. Wireways shall be sized so that the total cross-sectional area of the insulated wire and cable does not exceed 40% of the cross-sectional area of the wireways.

N. All wiring to panel door(s) shall be run in Braided Expandable Sleeving to protect against abrasion.

O. A minimum clearance of 30 mm shall be provided between wireways and any point of wire termination.

P. All panel wiring to a terminal strip shall come in from the right, and field wiring from the left.

Q. Firmly bond all panel mounted device on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

R. Type 12 enclosures shall be fabricated with necessary stiffening to form a rigid assembly. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry panels.

S. All wiring incoming and outgoing, shall terminate at terminal strips mounted inside panels.

T. All terminal strips must be identified with a terminal strip number as per the panel design drawings.

U. All terminal blocks must be identified on both sides with machine printed terminal markers as per the panel design drawings.

V. Grounding lugs shall be provided for each panel, suitable for termination of up to #2 AWG copper grounding conductor.

W. A copper ground bar inside the control panel for Teck cable ground and bond terminations shall be provided.

X. Provide an interior fluorescent or LED fixture switched on when panel door is opened.

Y. Each PLC input (digital and analog) shall have the input connected to a fused terminal block immediately upstream of the PLC card input terminal (positive input). Fuse block shall be equipped with an appropriately sized fast acting fuse to protect the PLC input.

Z. Equipped with a Surge Protection Device for the incoming 120 V(ac) power.

AA. Enclosures

1. Enclosures shall be NEMA rated and provided in accordance with Section 26 00 00 – Electrical Work General.

2. Enclosures shall be freestanding, pedestal-mounted, or equipment skid-mounted, as indicated. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white.

3. Outdoor mounted enclosures and enclosures in semi-heated spaces shall be provided with thermostatically-controlled heaters. The heater shall be an 120 volt, enclosed fan driven type with integral thermostat, and mounted on the back panel. The heater shall be sized to maintain the panel inside temperature above 50°F with the facility (and any PLC's) shutdown. Heaters shall be Hoffman model D-AH series, or equal.

4. Each panel 12-inch by 12-inch and larger shall be provided with a door stop to secure the door in the open position.

5. Enclosures containing electronic devices located outdoors and not shaded by other structures shall be constructed with a white painted sun shield over the top and south, west and east facing sides. Enclosures with electronic devices such as Programmable Logic Controllers (PLC's), flowmeter transmitters, etc. shall have a closed loop air conditioner on the north side. Louvers and/or openings which allow outside air into the enclosure are not acceptable.

6. Enclosures for PLC's shall have an switched internal LED light and NEMA 15 amp duplex receptacle labeled "TOOLS ONLY" for use by programming laptops, etc.

7. Enclosures with power supplies shall have a door mounted white "120VAC Power Available" light and an alarm light for each power supply.

8. Outdoor LCP enclosures (LCP-300,400,600) shall be complete with padlockable doors on the outside. Exterior doors shall be blank with all devices located internally. Provide deadfront panels/doors inside exterior lockable doors. Deadfront panel to include HMI's and selector switches, lamps, etc.

BB. Disconnect Switches

1. Heavy duty, non-fusible, single throw switches shall be rated not less than 65 kAIC at 480 VAC.

2. Horsepower rated

3. UL listed

4. Padlockable in "Off" position and door interlock

5. Enclosure per area classification in Section 26 00 00 – Electrical Work, General.

6. 480 VAC, 3-phase, 3-pole.

7. Auxiliary control contact as applicable and where indicated.

8. As manufactured by G.E., Eaton Electrical, Square D, or equal.

CC. Identification of panel-mounted devices, conductors, and electrical components shall be in accordance with Section 26 00 00 – Electrical Work, General.

DD. Panel-mounted devices shall be mounted a minimum of 3-feet above finished floor elevation, but not higher than 6'-6" above finished floor, unless noted otherwise.

EE. Where more contacts are shown or required for any type of relay coil, (control relay, time delay relay, latching relay, etc.), switch, or field device, the CONTRACTOR shall furnish, install and connect auxiliary relay(s) at no additional cost to the OWNER. Where interposing relays are required between devices but are not shown on the Contract Drawings, the CONTRACTOR shall furnish, install and connect interposing relay(s) at no additional cost to the OWNER.

FF. Equipment safety devices shall be hard-wired into the equipment control wiring to shut-down the equipment in any operating mode, or with the equipment mode selector switch in any operating position (HAND, AUTO, REMOTE, LOCAL, etc.). Equipment requiring the operator to reset the controls after correcting the adverse condition that triggered the shut down shall be provided with a momentary RESET button, or equipment mode selector switch OFF position that accomplishes the same function.

2.2 PANEL/STATION COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30 mm, and NEMA rated for the installation location. Miniature style devices are not acceptable. Devices shall be as manufactured by G.E., Square D Class 9001 Type K, Eaton Electric Type 10250T, Allen-Bradley Bulletin 800 Type T Eaton Electric, or equal.

B. Four (or more) position selector switches shall be of the heavy duty type. Switches shall have a rotary blades engaging separate contact banks for each set of contacts shown. Each contact shall have a screw type terminal for connecting control wires. Each shall have a factory engraved legend plate, and make-before-break or break-before-make contacts as indicated on the Contract Drawings. Four position selector switches shall be Electroswitch series 31 single-hole, or equal.

1. Lens colors shall be green for "run," "open," or "on"; red for "stopped," "closed," or "off"; and amber for alarm.

2. Pilot lights or 28 volts or less shall be Push-to-Test, light emitting diode (LED) type.

3. Pilot lights for greater than 28 volts shall be Push-to-Test, reduced voltage, transformer type. Lamp voltage shall be 12 volt maximum.

C. Relays shall be 3 PDT with 10 amp contacts, plug-in type with indicating light, rectangular blades and provided with sockets for screw-type termination and hold-down clips. Where more than 3 contacts are shown or required for a relay coil additional relay(s) shall be furnished installed and connected at no additional cost to the OWNER. Miniature or compact relays are not acceptable. Relays shall be as manufactured by Square D 8501 Type KU, Eaton Electric Type D5, Allen-Bradley Bulletin 700 Type HB, Potter Brumfield, or equal.

D. Latching relays shall be 2PDT with 10 amp contacts, indicating light, plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Where more than 2 contacts are shown or required for a relay coil additional relay(s) or auxiliary relay(s) shall be furnished installed and connected at no additional cost to the OWNER. Relays shall be as manufactured by Square D Class 8501 Type KL, Eaton Electric Type MR, Allen-Bradley Bulletin 700 Type HJ, Potter & Brumfield, or equal.

E. Time delay relays shall be electronic, combination on delay, off delay, interval, and one-shot (selectable) with adjustable timing ranges plug-in type utilizing rectangular blades and provided with sockets for screw-type termination and hold-down clips. Time delay relays shall at least 2PDT with 10 amp contacts. Where more than 2 contacts are shown or required for a relay coil additional relay(s) or auxiliary relay(s) shall be furnished installed and connected at no additional cost to the OWNER. Time delay relays shall be Square D Class 9050 Type JCK, Potter & Brumfield, or equal.

F. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by General Electric, Eaton Electrical, or equal.

G. Magnetic starters shall be:

1. NEMA rated, Size 1 minimum. IEC or dual NEMA/IEC rated type are not acceptable.

2. FVNR type unless indicated otherwise.

3. Combination starters with magnetic only instantaneous trip circuit breakers such as Eaton Electrical HMCP, General Electric Mag-Break, or equal. Breakers shall be rated 65 kAIC minimum.

4. Control transformers shall be provided with primary and secondary fuses, 120 V maximum control voltage. VA rating of transformer shall be based on devices on the control schematic.

H. Terminal blocks for control wiring shall be of the DIN rail mounting type rated at a minimum of 600 volt AC and minimum width of 8mm suitable for No. 12 AWG stranded wire minimum. Terminals shall be the solderless box lug type with pressure plates in actual contact with the wire to minimize wire breakage. Each terminal shall have a light colored strip for marking the terminal number or circuit designation. Double high terminal blocks are not acceptable. Circuit isolating switches and fuse terminals shall include non-conducting pullers which can be removed with finger alone, no tools required. Terminals shall be Square D Class 9080 Type M, Eaton Electric Type C383, Allen-Bradley Bulletin 1492 Type H and U, or equal. Provide 25 percent spare terminals in each panel.

I. Audible alarm horns shall be 100 decibels at ten feet minimum with a volume adjusting screw, and 120 VAC operation. Horns shall include all parts required for mounting in the location shown on the Contract Drawings. Horns installed as part of panels shall be surface mounted or flush with the face of the panel. No conduit or adapter boxes shall be mounted externally on the panel surface. Horns shall include all components including tone generators to provide a complete product. Audible alarm horns shall be Federal Signal Corp., Edwards, Allen-Bradley, or equal.

J. Alarm beacons shall have a yellow lens at least 6 inches (150mm) in diameter, flashing, rotating or strobe lamp, and accept 120 VAC nominal voltage. Alarm beacons shall be surface mounted to be visible to personnel away from the facility at fault. Coordinate exact locations with OWNER during construction. No conduit or adapter boxes shall be mounted externally on the panel surface. Alarm beacons shall include all components including mounting adapters to provide a complete product. If the alarm beacon provides an audible alarm horn then a separate audible alarm horn does not need be furnished. Alarm beacons shall be Allen-Bradley Bulletin 855BL, or equal.

K. Direct current power supplies shall have a precision regulated voltage of 24 volts nominal. Power supplies shall have an excess rated capacity of 40 percent. Power supplies shall receive 120 VAC nominal input voltage, input fuse or circuit breaker and be enclosed on all sides with screw terminals for all user connections. Open power supplies or ones using soldered terminals shall not be accepted. Power supplies shall be of the redundant dual type or shall be two power supplies wired in parallel, fully fused and protected from feeding power into the other power supply. Each power supply shall have a relay output for signaling failure. Power supplies shall be Moore Industries model SMP with SSM, or equal.

2.3 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. General: UPS's shall be sized to provide a minimum of ten minutes run time off the batteries at full load upon loss of utility power. Each PLC panel shall be provided with a commercially cataloged 120VAC 1 phase uninterruptible power supply (UPS).

B. UPS's shall be rated at a minimum of 2,000 volt-amperes, 120VAC, 1 phase output, distributed through a minimum of two NEMA 5-15R electrical receptacles. UPS's shall provide protection from blackouts, brownouts, and electrical surges. The following features shall be provided at a minimum: EMI/RFI filter, user replaceable batteries, ON/OFF switch, status indicator, replace battery indicator, audible low battery indicator, output circuit breaker and input power cord. Uninterruptible power supply's shall be APC, Best Power, or equal.

C. Electrical input shall be 120VAC, 1 phase from a dedicated NEMA 5-15R or 5-20R electrical receptacle labeled "UPS ONLY, NO TOOLS". The UPS shall plug into the receptacle, and the panel control wiring shall plug into the UPS. The control panel plug shall be able to plug directly into the receptacle when the UPS being repaired or replaced.

2.4 ETHERNET SWITCHES

A. mountable Ethernet switch providing adequate ports for connection of all communicating equipment. Ethernet switches shall be powered by 24 V(dc) power from control panel UPS power.

B. Acceptable manufacturer and model: N-TRON 116TX and N-TRON 108TX or equivalent.

2.5 SURGE PROTECTION DEVICE – CONTROL POWER

A. UL1449 2nd Edition rated using metal oxide varistors.

B. 120 V(ac), 15 A, 2 wire grounded input for

C. MCOV: 150 V.

D. Surge Current: 45 kA per phase.

E. 3 modes of protection.

F. Filtering Bandwidth: 10 kHz to 100 MHz.

G. Noise Attenuation: Normal Mode 75 dB at 100 kHz, Common mode 50 dB at 5 Mhz.

H. Let Through voltage: 6 V A3 ringwave, 9.6 V B3 Ringwave, 70 V, B3/C1 impulse.

2.6 WIREWAYS

A. Plastic wiring raceway with removable covers.

B. Raceway shall be sized for 35% wire fill.

C. Refer to detailed Drawings for proposed control panel internal wireway layout.

D. Wireways shall be manufactured by Panduit or approved alternate.

2.7 DC POWER SUPPLY

A. DIN rail mounted.

B. Redundancy Modules for PRAS-CP-001 and PRAS-CP-002.

1. Two (2) power supply units per panel.

C. Input voltage 85-230 VAC.

D. Output voltage 24 VDC output adjustable to + 10%.

E. Power and Current: 240W, 10A

F. Power output as required with 25% spare capacity.

G. Built-in overload protection.

H. 0.5% voltage regulation Minimum-Maximum input voltage.

I. 1.0% voltage regulation 10% to 100% load.

J. Acceptable manufacturers:

1. Weidmueller PROTOP1

2. Approved equivalent

2.8 WRAP-AROUND BYPASS

A. Wrap-around bypass systems shall be provided

B. UPS shall be complete with a 120V(ac), 15 A wrap-around bypass switch, complete with automatic transfer switch and FORM C output.

2.9 FACTORY TESTING

A. Each panel/station shall be factory assembled and tested for sequence of operation prior to delivery.

2.10 SPARE PARTS

A. For the entire project provide:

1. A minimum of 10 percent spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

2. Five spare control fuses of each type (voltage, amperage, form) installed.

3. Two spare relays and bases of each type installed.

4. One power supply (and switching module if applicable) of each type installed

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Panels/stations shall be installed in accordance with in Section 26 00 00 – Electrical Work, General and in accordance with the manufacturer's recommendations.

B. Panels/stations shall be protected at the site from loss, damage, and the effects of weather. Panels/stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.

C. Panels/station interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the WORK.

D. Conduit, conductors, and terminations shall be installed in accordance with Section 26 00 00 – Electrical Work, General.

3.2 SIGNAL AND CONTROL CIRCUIT WIRING

A. Wiring Installation: All wires shall be run in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, (3) wiring from components on a swing-out panel to components on a part of the fixed structure, and (4) wiring to panel-mounted components. Wiring run from components on a swing-out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at the terminals. Wire bundles from door mounted components shall land on terminals on the back panel before continuing to back panel mounted devices so the door wiring can easily be tested and field modified. Wire bundles from door mounted components to terminals on the back panel shall include a minimum of four spare wires.

B. Panels/stations shall be installed in accordance with in Section 26 00 00 – Electrical Work, General and in accordance with the manufacturer's recommendations.

C. All external connections to and from panels shall terminate on terminal blocks except approved analog signal and communications cables.

D. Wire Marking: All conductors connected to a given electrical point shall be designated by a single unique number which shall be shown on all shop drawings. These numbers shall be marked on all conductors at every terminal.

E. Terminals and fuses for each conductor and shield drain wire of a twisted shielded pair or triad cable shall be mounted consecutively next to each other. The horizontal and vertical arrangement of the positive, negative and ground terminals shall be consistent in all panels.

3.3 EQUIPMENT IDENTIFICATION

A. Nameplates shall be provided for all components mounted in or on panels. In addition to name plates, control devices shall be equipped with standard collar-type legend plates. Nameplates shall meet the requirement of Section26 00 00 – Electrical Work, General.

B. Control devices mounted through the enclosures door(s) shall be identified on both the outside and inside of the door.

C. All conduits (filled or empty) terminating in panels shall be tagged in accordance with Section 26 05 33 - Electrical Raceway Systems.

D. The CONTRACTOR shall furnish typewritten fuse directory listing the location, type, voltage and ampere rating of each fuse installed in the panel.

3.4 FIELD TESTING

A. Each panel/station shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.

END OF SECTION

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SECTION 26 05 19 - WIRE AND CABLING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

B. In the event that motors provided are larger horsepower than the motors indicated, raceways, conductors, starters, overload elements, and branch circuit protectors shall be revised as necessary to control and protect the increased motor horsepower in accordance with Section 26 05 10 - Electric Motors. Revisions are part of the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. The CONTRACTOR shall submit Shop Drawings in accordance with Sections 01 33 00 - Contractor Submittals and 26 00 00 - Electrical Work, General.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Conductors, include grounding conductors, shall be stranded copper.

B. Aluminum conductor wire and cable will not be permitted.

C. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity.

D. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

2.2 LOW VOLTAGE WIRE AND CABLE

A. Power and Lighting Wire

1. Wire rated for 600 volts in duct or conduit for power and lighting circuits shall be Class B Type XHHW or XHHW-2 cross-linked polyethylene conforming to UL-44 - UL Standard for Thermoset-Insulated Wires and Cables.

2. THHN/THWN wire shall not be permitted to be used for any power or control wiring in this project, except as specifically permitted within control panels per Section 40 95 13 - Control Panels.

3. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

4. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

5. Wiring for 600 volt class power and lighting shall be as manufactured by Okonite, General Cable, Southwire, or equal.

6. 1000V XLPE insulation rating for incoming Utility and Generator feeds.

B. Control Wire

1. Control wire in duct or conduit shall be the same type as power and lighting wire indicated above.

2. Control wiring shall be No.14 AWG.

3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by American, General Cable, or equal.

4. Insulation rating: 300V (min.)

C. Instrumentation Cable

1. Instrumentation cable shall be rated at 600 volts.

2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded pvc/nylon: black-white for 2 conductor cable and black-red-white for 3 conductor cable.

3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 22 or larger AWG stranded tinned copper drain wire, and a PVC outer jacket with a thickness of 0.047-inches.

4. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A,** similar by **General Cable,** or equal.

5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A,** similar by **General Cable,** or equal.

6. Insulation rating: 300V (min.)

D. VFD Power Cable

1. VFD power cable shall be three (3) conductor, stranded copper, PVC jacketed, shielded type, tray cable (TC) rated 600 volts with three (3) symmetrical ground conductors. The individual conductors shall be UL listed as Type XHHW-2 or RWH-2 rated for 90 degrees C at wet and dry locations, with XLPE insulation.

2. VFD Cables shall be as manufactured by **Belden, Alpha**, **General Cable,** or equal.

2.3 CABLE SPLICES AND TERMINATIONS

A. Compression connectors shall be **Burndy Hi Lug, Thomas & Betts Sta-Kon,** or equal. Threaded connectors shall be split bolt type of high strength copper alloy. Pressure type, twist-on connectors (wire nuts) will not be acceptable.

B. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy,** or equal.

C. General purpose insulating tape shall be **Scotch No. 33, Plymouth Slip-knot,** or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M,** or equal.

D. Labels for coding 600 volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M,** or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall provide, terminate and test all power, control, and instrumentation conductors.

B. The CONTRACTOR shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares.

3.2 INSTALLATION

A. Conductors shall not be pulled into raceway until raceway has been cleared of moisture and debris.

B. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

C. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.

3.3 SPLICES AND TERMINATIONS

A. General

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.

2. In general, there shall be no cable splices in underground manholes or pullboxes. If splices are necessary, the cables shall be spliced using submersible cable splices, suitable for continuous submergence. Splices in underground manholes and pullboxes may be made only with the approval of the ENGINEER.

3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.

2. In control panels/stations, control wire and spare wire shall be terminated to terminal strips.

3. The CONTRACTOR shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4-20 mA system.

2. Two and 3 conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes with the prior approval of the ENGINEER. Such cable runs shall have only one splice per conductor.

D. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the CONTRACTOR. Cables rated above 2,000 volts shall be spliced or terminated only at equipment terminals indicated.

2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape over-taped with a minimum of 2 layers of high temperature tape.

3. VFD shielded power cables shall have the shield grounded at all locations where it is exposed.

3.4 CABLE IDENTIFICATION

A. **General:** Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

B. **Identification Numbers:** The CONTRACTOR shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control Conductor" shall be defined as any conductor used for alarm, annunciator, or signal purposes.

1. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.

2. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 120/240-volt system conductors shall be color coded as follows: Line 1 - Black, Line 2 - Red, and Neutral - White. The 480/277-volt system conductors shall be color coded as follows: Phase A - Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Color coding tape shall be used where colored insulation is not available. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Any phase changes necessary for proper rotation shall be made at the driven equipment and not in the local disconnect.

3. General purpose AC control cable shall be red. General purpose DC control cable shall be blue.

4. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

5. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

3.5 TESTING

A. **Cable Assembly and Testing:** Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Section 01 33 00 - Contractor Submittals, prior to shipment of cable. The following field tests (in addition to the tests specified in Section 26 01 26 - Electrical Tests) shall be the minimum requirements:

1. Insulation resistance testing, using a DC megohmeter, shall be performed on cables operating at more than 2,000 volts to ground. Time-resistance readings shall be taken and recorded at intervals of 30 seconds and one minute. Time-resistance voltage levels shall be per the cable manufacturer's recommendations.

2. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmeter.

3. Field testing shall be done after cable is installed in the raceways.

4. Field tests shall be performed by a certified test organization acceptable to the cable manufacturer. Test results shall be submitted to the ENGINEER for review and acceptance.

5. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

B. **Continuity Test:** Control and instrumentation cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

END OF SECTION

SECTION 26 05 26 – GROUNDING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical grounding system, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit manufacturer's product information for connections, clamps, and grounding system components, showing compliance with the requirements of this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Components of the grounding electrode system shall be manufactured in accordance with UL 467 - Standard for Safety Grounding and Bonding Equipment, and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

2.2 GROUNDING SYSTEM

A. Grounding loop conductors shall be bare annealed copper conductors.

B. Conductors shall be No. 1/0 unless indicated otherwise.

C. Ground Rods

1. Unless indicated otherwise, provide ground rods minimum of 3/4 inch in diameter, 10 feet long, and with a uniform covering of electrolytic copper metallically bonded to a rigid steel core.

2. Provide corrosion-resistant copper-to-steel bond.

3. The rods shall conform to UL 467.

4. The rods shall be of the sectional type, joined by threaded copper alloy couplings.

D. Make buried and concrete-encased cable-to-cable and cable-to-ground rod connections using exothermic welds by **Cadweld, Thermoweld,** or equal, or irreversible compression connections.

E. Exposed Connectors

1. Exposed grounding connectors shall be of the compression type (connector-to-cable), constructed of high-copper alloy, and manufactured specifically for the particular grounding application.

2. The connectors shall be **FCI-Burndy, O.Z. Gedney**, or equal.

F. Use grounding clamps to bond each separately-derived system to the grounding electrode conductors.

G. Equipment Grounding Circuit Conductors

1. The conductors shall be the same type and insulation as the load circuit conductors.

2. The minimum size shall be as outlined in Table 250.122 of the National Electrical Code, unless indicated otherwise.

3. Metallic conduit systems shall have an equipment grounding wires as well as being equipment grounding conductors themselves.

H. Grounding Materials Manufacturer, or Equal

1. **Copperweld**

2. **Thermoweld**

3. **FCI-Burndy**

PART 3 -- EXECUTION

3.1 GROUNDING

A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.

B. Provide a separate grounding conductor for each motor and connect at motor box.

C. Do not use bolts for securing the motor box to the frame or the cover for grounding connectors.

D. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.

E. Route the conductors inside the raceway.

F. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each switchboard, or panelboard.

G. Individually bond the raceway to the ground bus in the secondary section.

H. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.

I. Provide a separate grounding conductor in each individual raceway for parallel feeders.

J. Interconnect the secondary switchboard or panelboard neutral bus to the ground bus in the transformer secondary compartment only at the service entrance point or after a transformer.

K. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system.

L. Low Voltage Grounded System (600V or less)

1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.

2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.

3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.

M. Embedded Ground Connections

1. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.

2. The connection shall be made in accordance with the manufacturer's instructions.

3. Do not conceal or cover ground connections until the ENGINEER or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the CONTRACTOR written confirmation.

N. Ground Ring

1. Furnish trenching and materials as necessary to install the ground ring as indicated.

2. The bonding conductor shall be in direct contact with the earth and of the indicated size.

3. Provide a minimum burial depth of 36-inches or as indicated on the Drawings, whichever is greater.

4. Re-compact disturbed soils to their original density in 6-inch lifts.

O. Ground Rods

1. Provide ground rods at the indicated locations.

2. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.

3. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.

4. Rods forming an individual ground array shall be equal in length.

P. Shield Grounding

1. Shielded instrumentation cable shall have its shield grounded at one end only unless the Shop Drawings indicate that the shield will be grounded at both ends.

2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.

3. The termination of the shield drain wire shall be on its own terminal screw.

4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.

5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INLCUDES

A. Conduit and equipment supports.

B. Anchors and fasteners.

1.2 REFERENCE STANDARDS

A. NEC (National Electrical Code)

B. UL (Underwriters' Laboratories Inc.)

1.3 **ACTION SUBMITTALS**

A. Section 01 33 00 – Submittal Procedures.

B. Product Data: Provide manufacturer's catalogue data for fastening systems.

1.4 **INFORMATIONAL SUBMITTALS**

A. Section 01 33 00 – Contractor Submittals.

B. Installation Data: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

PART 2 - PRODUCTS

2.1 **DESCRIPTION**

A. Regulatory Requirements

1) Provide products listed and classified by UL as suitable for purpose specified and shown.

2.2 **PRODUCT REQUIREMENTS**

A. Materials and Finishes: Provide adequate corrosion resistance.

B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products

2.3 CONDUIT SUPPORTS

A. Single runs: Galvanized conduit straps, Gripple or ringbolt type hangers.

B. Multiple runs three or more: Conduit rack with 25% spare capacity.

C. Vertical runs: Channel support with conduit fittings.

D. Conduit supports for runs of multiple diameters shall be spaced according to the code requirement for the small diameter pipe.

2.4 SUPPORT CHANNELS

A. U shape, size 41 X 41 mm, 2.5 mm thick, surface mounted, suspended, set in poured concrete walls and ceilings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products to manufacturer's written instructions.

B. Provide anchors, fasteners, and supports to NEC.

C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

D. Do not use powder-actuated anchors.

E. Do not drill or cut structural members.

F. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

G. Install surface-mounted cabinets and panelboards with minimum of four anchors.

H. In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 inch off wall).

I. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

J. Secure equipment to solid masonry, tile, and plaster surfaces with lead anchors.

K. Secure equipment to poured concrete with expandable inserts.

L. Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

M. Fasten exposed conduit or cables to building construction or support system using straps.

N. One-hole malleable iron straps to secure surface conduits and cables 50 mm and smaller.

O. Two-hole steel straps for conduits and cables larger than 50 mm.

P. Beam clamps to secure conduit to exposed steel work.

Q. Suspended support systems.

R. Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips or Gripple hangers.

S. Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod or Gripple hangers where direct fastening to building construction is impractical.

T. For surface mounting of two or more conduits use channels at 1.5 m on center spacing.

U. Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

V. Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

W. Do not use wire lashing or perforated strap to support or secure raceways or cables.

X. Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.

Y. Install fastening and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

Z. Install to maintain headroom, neat mechanical appearance and to support equipment loads required.

AA. Where inserts are required in concrete, lead inserts may be used in drilled holes. Wood or fiber plugs are not permitted. Shot driven pins shall NOT be used.

BB. Install supports as required for mounting equipment such as HOA/pushbuttons, small panels, and field instruments where building structural supports are not within proximity to equipment location.

END OF SECTION

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SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

2. As-Built Drawings

a. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

b. Furnish the drawings to the ENGINEER in accordance with THE SUMMARYs of Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pull and junction boxes, fittings, and other indicated enclosures that are dedicated to the raceway system shall comply with THE SUMMARY of this Section.

2.2 CONDUIT

A. Rigid Aluminum (RAL) Conduits shall not be used.

B. Rigid Galvanized Steel (RGS) Conduit

1. Provide rigid steel conduit manufactured from mild steel, hot-dip galvanized inside and out.

2. Provide rigid steel conduit manufactured in accordance with NEMA C80.1 – Electrical Rigid Steel Conduit, and UL-6 – Electrical Rigid Metal Conduit - Steel.

3. Manufacturer, or Equal

    a. **Allied Tube & Conduit**

    b. **Triangle**

    c. **Wheatland Tube**

C. Rigid Non-Metallic Conduit

1. Provide rigid non-metallic conduit manufactured from Schedule 40 or 80 PVC, as indicated, and sunlight-resistant.

2. Provide rigid non-metallic conduit manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.

3. Manufacturer, or Equal

    a. **Carlon**

    b. **Cantex**

D. Rigid PVC-Coated Galvanized Steel (RPGS) Conduit

1. The conduit shall meet THE SUMMARYs for RGS conduit as indicated above.

2. Bond a PVC coating to the outer surface of the galvanized conduit.

3. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating.

4. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating.

5. Provide a PVC coating thickness not less than 40 mils.

6. The PVC-coated RGS shall be manufactured in accordance with the following standards:

    a. UL-6

    b. ANSI C80.1

    c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

7. Manufacturer, or Equal

    a. **Robroy Industries, Perma-Cote**

    b. **Robroy Industries, Plasti-Bond RedH2OT**

c. **Robroy Industries, Korkap**

d. **Thomas & Betts, Ocal Blue**

E. Polyolefin Polymer-Coated Rigid Galvanized Steel Conduit:

1. All conduit shall be hot dipped galvanized inside and out with hot dipped galvanized factory-cut threads. The Zinc coating shall be intact, uncoated, and shall not impede electrical ground conductivity.

2. Provide all necessary manufacturer material as may be needed to ensure a fully complete, continuously sealed, undamaged conduit system.

3. Provide additional polymer and repair any abrasions to polymer coating.

4. Polymer-coated RGS conduit shall be resistant to UV damage and deterioration when exposed outdoors.

5. All PP-coated conduit, fittings, and accessories shall be supplied by the same manufacturer.

6. All couplings and fittings shall be provided with PP-coated sleeves and seals, unless otherwise approved by the ENGINEER.

7. Material:

a. Conduit: Meet requirements of ANSI C80.1 and UL 6.

b. Polyolefin Polymer Coating:

1) Minimum 20 mils nominal thickness, exterior coating bonded to metal.

2) Minimum 2 mils nominal thickness, interior coating bonded to metal.

8. Manufacturer, or Equal

a. **Gafco Green**

b. **Cor-Shield**

F. Liquid-Tight Flexible Conduit

1. Provide liquid-tight flexible conduit constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.

2. Provide liquid-tight flexible conduit manufactured in accordance with THE SUMMARYs of UL-360 - Steel Conduits, Liquid-Tight Flexible.

3. Manufacturer, or Equal

a. **Anaconda, Sealtite**

b. **Electriflex, Liquatite**

G. Electrical Metallic Tubing (EMT) or Intermediate conduit (IMC) will not be accepted.

2.3 FITTINGS AND BOXES

A. General

1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.

2. Fittings and Boxes

a. Provide fittings and boxes with neoprene gaskets and non-magnetic stainless steel screws.

b. Attach covers by means of holes tapped into the body of the fitting.

c. Covers for fittings attached by means of clips or clamps will not be accepted.

3. Provide boxes larger than standard cast or malleable types manufactured of Type 304 or Type 316 stainless steel, NEMA 4X.

4. Terminations

a. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, Appleton, or equal.

b. In other than outdoor areas, provide sealed locknuts and bushings.

B. Malleable Iron Fittings and Boxes

1. For use with galvanized steel conduit, provide fittings and boxes constructed of malleable iron or gray-iron alloy with zinc plating.

2. Manufacturer, or Equal

a. **O.Z. Gedney**

b. **Crouse-Hinds**

c. **Appleton**

C. PVC Fittings and Boxes

1. For use with rigid non-metallic conduit, provide fittings manufactured of solvent-welded PVC.

2. Provide boxes manufactured of PVC or fiberglass reinforced polyester (FRP).

3. Manufacturer, or Equal

a. **Carlon**

b. **Crouse-Hinds**

c. **Hoffman**

4. Provide welding solvent as required for the installation of non-metallic conduit and fittings.

D. PVC-Coated Fittings

1. For use with PVC-coated RGS, provide PVC-coated coated that are the products of the same manufacturer as the conduit.

2. Provide male and female threads and internal surfaces with a 2-mil urethane coating.

E. Stainless Steel Boxes

1. Provide stainless steel boxes with PVC-coated RGS conduit and where indicated.

2. Provide NEMA 4X stainless steel boxes, constructed of Type 304 or 316 stainless steel.

3. Provide stainless steel of a minimum of 14-gauge thickness, with a brushed finish.

4. Door Hinges

a. Provide doors with full-length stainless steel piano hinges.

b. Non-hinged boxes will not be accepted.

5. Manufacturer, or Equal

a. **Hoffman**

b. **Rohn**

c. **Hammond**

F. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.

2. Manufacturer, or Equal

a. **Raco**

b. **Steel City**

c. **Appleton Electric**

2.4 WIREWAY

A. General

1. Provide wireway of the lay-in type and NEMA-rated for the area in which it is to be installed in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General.

2. Separate power, control, signal and communications cables by grounded metallic dividers in wireways or run in separate wireways.

B. Fittings and Covers

1. Provide fittings and sections with non-magnetic stainless steel screws.

2. Attach covers by hinges and clamps to the bodies.

3. Covers attached by means of clips or screws will not be accepted.

4. Provide covers and bodies constructed of minimum 14-gauge steel.

C. Grounding

1. Ground the steel and aluminum wireway bodies.

2. Provide steel dividers with steel wireways and ground by means of an individual grounding conductor.

3. Non-metallic dividers will not be accepted.

D. Terminations

1. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by **Myers, O.Z. Gedney**, or equal.

2. In other than outdoor areas, provide sealed locknuts and bushings.

PART 3 -- EXECUTION

3.1 GENERAL

A. Run wiring in raceway unless indicated otherwise.

B. Install raceways between equipment as indicated.

C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.

D. Bends and Offsets

1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.

2. Provide factory elbows wherever possible.

E. Combined Raceways (power and control/signal) shall not be allowed except where specifically shown on the drawings.

F. Routing

1. Where raceway routings are indicated, follow those routings to the extent possible.

2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the CONTRACTOR's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.

4. Adjust routings in order to avoid obstructions.

G. Coordination

1. Coordinate between trades prior to installing the raceways.

2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.

H. Support wireways in accordance with the manufacturer's recommendations for the seismic requirements indicated in Section 26 00 00 – Electrical Work, General.

I. Install exposed raceways parallel or perpendicular to structural beams.

J. Expansion Fittings

1. Install expansion fittings with external bonding jumpers wherever exposed raceways cross building expansion joints.

2. Install expansion/deflection fittings where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur.

3. Encased Expansion Fittings

a. Install encased expansion fittings wherever encased conduits cross building expansion joints.

b. Deflection type fittings shall not be required for encased conduits crossing an expansion joint within a single structure.

4. Provide expansion and expansion/deflection fittings constructed of the same material as the raceway to which they are installed.

K. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

L. Install exposed raceways at least 1/4 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.

M. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

3.2 CONDUIT

A. Provide exposed conduit manufactured of rigid galvanized steel, except as follows and unless indicated otherwise:

1. For conduit containing only grounding system bonding conductors, provide Schedule 80 PVC conduit.

B. Power conduit encased in concrete shall be constructed of Schedule 40 PVC.

C. Analog control or instrumentation conduit shall be RGS.

D. Concrete Encasement

1. Where PVC or RGS conduit is stubbed up from a concrete encasement, provide a PVC-coated RGS elbow.

2. The conduit shall emerge from the concrete in a direction perpendicular to the surface whenever possible.

3. Do not encase conduit in the bottom floor slab below grade.

E. Size

1. Provide exposed conduit of 3/4-inch minimum trade size.

2. Provide encased conduit of one-inch minimum trade size.

F. Install supports at distances required by the NEC.

G. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.

H. Penetrations

1. Provide conduit passing through walls or floors with plastic sleeves.

2. Perform core drilling in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General.

3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

I. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall meet the following requirements:

1. Conduits with their fittings embedded within a column shall not displace greater than 4 percent of the gross area of cross section;

2. Conduits shall not be larger in outside dimension than 1/3 the overall thickness of the slab, wall, or beam in which it is embedded; and,

3. Conduits shall not be spaced closer than 3 outside diameters on centers.

J. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.

K. Coat threads with a conductive lubricant before assembly.

L. Joints

1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.

2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.

3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.

4. Replace conduit with wrench marks.

M. Slope

1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.

2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.

3. Take extreme care in order to avoid pockets or depressions in the conduit.

N. Installation of rigid steel conduit though a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.

O. Connections

1. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.

2. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.

P. Provide conduit, fittings, and boxes required in hazardous classified areas that are suitably rated for the area, and provide in strict accordance with NEC requirements.

Q. Empty Conduits

1. Tag empty conduits at both ends to indicate the final destination.

2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.

3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

R. Identification of Conduits

1. Identify conduits at ends and at pulling points.

2. Identification shall be the unique conduit number assigned in the Contract Documents.

3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.

4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

5. Provide conduit identification by a stamped or engraved non-corroding metal tag attached to the conduit bushing.

6. Provide an engraved phenolic nameplate in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.

7. Markings with a pen or paint will not be accepted.

S. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.

2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the CONTRACTOR shall assign one following the numbering scheme used in the Contract Documents.

3. Provide box identification by a stamped or engraved non-corroding metal tag or an engraved phenolic nameplate, in accordance with THE SUMMARYs of Section 26 00 00 – Electrical Work, General, and attached to the box or enclosure.

4. Markings with a pen or paint will not be accepted.

T. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

END OF SECTION

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SECTION 26 05 35 – MOTORS AND MOTORIZED ACTUATORS

PART 1 -- GENERAL

1.1 RELATED WORK

A. Division 22 – Plumbing

B. Division 23 – Section 23 05 13 – Common Motor Requirements Systems for HVAC Equipment

C. Section 26 05 00 – Common Work results for Electrical

D. Division 40 – Process Interconnects

1.2 ACCEPTABLE SUPPLIERS

A. Control Valve Actuators

1. Rotork

2. Approved alternate

B. Motors

1. General Electric

2. Hyundai

3. Reliance

4. Toshiba

5. US Motor

6. Grundfos

7. WEG

8. Approved alternate

1.3 COORDINATION WITH OTHER DIVISIONS

A. Coordinate all motor requirements with Division 23 (HVAC) and Division 40 (process) for specific applications.

PART 2 -- PRODUCTS

2.1 MOTORS

A. Unless otherwise specified, motors less than 250 W or less shall be 120 V, single phase, 60 Hz, and all motors over 250 W shall be 208 V (single phase / three phase) or

480 V, three phase, 60 Hz, as indicated in the detailed Drawings. Vendor package motor requirements shall be per vendor requirements.

B. All 3 phase motors shall have class F insulation with class B rise, 1.15 SF, high efficiency and high power factor, rated for use with VFDs (inverter duty rated) where required.

C. If the motor comes complete with integral thermal protection, the motor shall use the integral protection provided by the manufacturer.

D. Notwithstanding 2.1.3, motors smaller than 112 kW shall be equipped with thermal winding temperature switches and motors larger than 112 kW shall be equipped with 100 Ohm platinum RTD winding temperature detectors, wired to separate terminal box unless otherwise specified.

E. Motor enclosures shall be TEFC unless otherwise indicated.

F. Two speed motors shall be two winding design.

G. Motors powered by AC Variable Speed Drives (Inverter Grade)

1. Motors shall be designed for use on generic PWM waveform to meet NEMA MG1, Part 31, Section 31.40.4.2.

2. Motors shall be capable of operating a variable torque load over a 5:1 speed range.

3. Motors shall be marked with UL and have in addition to the normal motor marking:

a. Motor application (e.g. Inverter-duty);

b. Speed range over which the machine is designed to operate;

c. Type of torque application for which the machine is designed e.g. VT (variable torque), CT (constant torque), CHp (constant horsepower) or equivalent; and

d. Type of inverter it is designed for e.g. PWM (pulse width modulated).

4. Where identified in the detailed drawings or specified herein, provide motors with overtemperature / leak detection sensors, relays, and/or controllers. Install as per drawings and specifications.

2.2 MOTORIZED ACTUATORS

A. General

1. Supply voltage as indicated on the drawings.

2. Provide motor operators including the motor, power gearing, torque switches and auxiliary handwheel or chain-operated handwheel, as a self-contained unit for the motor operated valves as shown on the drawings.

3. Power gearing enclosures shall be of cast aluminum and gears shall run in oil or grease. Fill and drain plugs shall be provided for oil and bottom head lubrication fittings for grease.

4. Operator shall be furnished with handwheel or chain-operated handwheel for emergency manual operation. The handwheel shall not rotate when motor is energized. Motor rotor shall not rotate when handwheel is in use.

5. The handwheel shall engage by means of an automatic declutching device. Handwheels shall not require more than 180 N pull at the rim to operate.

6. Electric motors for motorized actuators shall be UL approved, totally enclosed, non-ventilated with Class B insulation and windings specially impregnated to prevent moisture absorption. Unless otherwise specified, actuators shall operate on 480 Volt 3 phase, 60 hertz power and shall be capable of 1,200 starts per hour on modulating duty.

7. A thermal protector, CGE Thermo-Tector or approved alternative shall be embedded in the windings to stop the motor on over-heating. The motor shall be de-energized in the event of a stall.

2.3 SOLENOIDS

A. General

1. 120VAC, 60HZ

2. Normally Closed (N.C)

3. Position open status

4. ASCO or equivalent

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Confirmation and coordination are required for final connections, loads and locations of motors, prior to installation.

B. Motors for mechanical equipment installed by that trade. Location of motors, conduit and connection points shown for equipment supplied by the mechanical trade are for estimating purposes only.

C. Provide line voltage connections for all mechanical equipment.

D. Use liquid tight flex for all motor connections from conduit systems.

E. Confirm proper nameplate markings before hooking up motors intended for use with AC variable speed drive.

F. Confirm that two speed motors are of the isolated, two winding design. If not isolated winding advise Consultant and do not terminate.

3.2 FIELD QUALITY CONTROL

A. Operate switches, contactors to verify correct functioning.

B. Perform Starting and Stopping sequences of contactors and relays.

C. Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

D. Complete lockout tests for operation in both local and remote. Note and record any problems and notify the Province before equipment is turned over.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide underground raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. Manholes, pullboxes, and fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of all raceways, fittings, pullboxes, and manholes, marked where applicable in order to show proposed materials and finishes.

C. As-Built Drawings

1. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

2. Show routings, burial depths, manhole and handhole locations and sizes, and where applicable, connections to drainage systems.

3. Furnish the drawings to the ENGINEER in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 PULLBOXES

A. Frames and Covers

1. Provide traffic-type covers with an H-20 loading, except as otherwise indicated.

2. Identify pullbox covers as "ELECTRIC" by providing raised letters cast into the covers.

B. Equip pullboxes with pulling-in irons, opposite and below each ductway entrance.

C. Provide pullboxes with closed bottoms; open-bottom pullboxes will not be accepted.

D. Precast Pullboxes Manufacturer, or Equal

1. **Jensen Precast**
2. **Mack**
3. **Quikset**

4. **U.S. Precast**

2.2 DUCTBANKS

A. Provide underground ducts constructed of Schedule 40 PVC. Ductbanks are not required to be concrete encased. Provide concrete cover over underground ducts where required by the NEC.

B. Identification Tape

1. Provide continuous lengths of underground warning tapes located 12-inches above and parallel to the ductbanks.

2. Provide tape consisting of 6-inch wide polyethylene film, imprinted with "CAUTION - ELECTRIC UTILITIES BELOW."

3. Provide tape that contains a non-ferrous metal foil conductor sandwiched in the tape for detection purposes.

4. Tape Manufacturer, or Equal: **Brady**

PART 3 -- EXECUTION

3.1 GENERAL

A. Install underground raceways between pullboxes as indicated.

B. Raceway systems shall be electrically and mechanically complete before conductors are installed.

C. Provide bends and offsets that are smooth and symmetrical, and fabricated with tools designed for this purpose.

D. Use factory elbows wherever possible.

E. To the extent possible, follow the raceway routings as indicated on the Drawings.

F. Adjust the indicated routings as necessary in order to avoid obstructions.

G. Coordination with Other Trades

1. Coordinate with other trades prior to installation of raceways.

2. The lack of coordination shall not be justification for extra compensation.

3. Perform removal and re-installation to resolve conflicts as part of the WORK.

3.2 DUCTBANKS

A. Install ductbanks in accordance with the following criteria:

1. Assemble the duct using high-impact, non-metallic spacers and saddles in order to provide conduits with vertical and horizontal separation.

2. Set the plastic spacers every 5 feet.

3. Anchor the duct array every 5-feet in order to prevent movement during the placement of backfill.

4. Lay the duct on a grade line of at least 3-inches per 100-feet, sloping towards pullboxes.

5. Install the duct and adjust the pullbox depths such that the top of the concrete envelope is a minimum of 18-inches below grade and a minimum of 24-inches below roadways.

6. Accomplish changes in direction of the duct envelope by more than 10 degrees horizontally or vertically by using bends with a minimum radius 24 times the duct diameter.

7. Stagger duct couplings a minimum of 6 inches.

8. Provide select backfill or sand for the bottom of the trench.

9. Cleaning

   a. Clean each bore of the completed ductbank by drawing through it a standard flexible mandrel, one foot long and ¼-inch smaller than the nominal size of the duct.

   b. After passing the mandrel, draw through a wire brush and swab.

10. For spare raceways that are not indicated to contain conductors, provide a 1/8-inch polypropylene pull cord installed throughout the entire length of the raceway. Cover the ends of all spare raceways.

B. Grout duct entrances smooth, and terminate ducts with flush end bells.

C. Assemble sections of pre-fabricated pullboxes using waterproof mastic, and set on a 6-inch bed of gravel as recommended by the manufacturer or as required by field conditions.

D. Provide watertight ductbank penetrations through walls of pullboxes, and building walls below grade.

E. When duct enters the building on a concrete slab on grade transition to rigid steel PVC-coated conduits on stub-ups.

F. Sealing

1. Where an underground conduit enters a structure through a concrete roof or a membrane-waterproofed wall or floor, provide a **Link-Seal** or equal sealing device.

2. Use the sealing device with rigid steel conduit.

3. Transition from PVC to rigid steel conduit prior to building entry.

END OF SECTION

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SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Restraints - rigid type.
3. Restraints - cable type.
4. Restraint accessories.
5. Post-Installed concrete anchors.
6. Concrete inserts.

B. Related Requirements:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load capacity for each seismic restraint device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic restraint component used.

3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by UL product listing.

4. Annotate to indicate application of each product submitted and compliance with requirements.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal for Each Seismic-Restraint Device: Signed and sealed by qualified structural professional engineer.

1. For each seismic-restraint device, including restraint - rigid and cable type, restraint accessory, and concrete anchor and insert that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
c. Seismic Design Calculations: Submit input data and loading calculations prepared under "Seismic Design Calculations" Paragraph in "Performance Requirements" Article.

2. Product Listing, Preapproval, and Evaluation Documentation: By UL, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage qualified structural professional engineer to design seismic control system in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical" and Section 260011 "Facility Performance Requirements for Electrical."

B. Seismic Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: UL product listing.

C. Consequential Damage: Provide additional seismic restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components so that failure of a non-essential or essential component will not cause failure of any other essential building component.

D. Fire/Smoke Resistance: Seismic restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

E. Component Supports:

1. Load ratings, features, and applications of reinforcement components must be based on testing standards of a nationally recognized testing agency.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.

2.3 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.4 RESTRAINTS - CABLE TYPE

A. Seismic[- and Wind-Load]-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel, ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket, or mechanical (Flemish eye) loop.

B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.5 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections, Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.6 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Provide post-installed concrete anchors that have been prequalified for use in seismic and wind-load applications.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW) that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.7 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC446 testing.

B. Comply with MSS SP-58.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES, OSHPD (an agency acceptable to authorities having jurisdiction).

B. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static, and seismic loads within specified loading limits.

3.3 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

A. Provide seismic restraint [**and wind-load control**]devices for systems and equipment where indicated in Equipment Schedules or Seismic and Wind-Load Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

1. Install equipment and devices to withstand the effects of earthquake motions[**and high wind events**].

B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

C. Installation of seismic[**and wind-load**] restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.

D. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES, OSHPD, an agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES, OSHPD, an agency acceptable to authorities having jurisdiction] that provides required submittals for component.
3. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
4. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES, OSHPD, an agency acceptable to authorities having jurisdiction] that provides required submittals for component.

F. Install cables so they do not bend across edges of adjacent equipment or building structure.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Field tests must be witnessed by authorities having jurisdiction

B. Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and "Field Quality Control" articles in Section 260010 "Supplemental Requirements for Electrical."

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

D. Nonconforming Work:

1. Seismic controls will be considered defective if they do not pass tests and inspections.
2. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION

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SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 -- GENERAL

1.1 SECTION INCLUDES

A. Nameplates and labels

B. Wire markers

C. Conduit markers

D. Underground warning tape

1.2 RELATED REQUIREMENTS

A. Section 09 91 00 – Painting

1.3 REFERENCE STANDARDS

A. NEC (National Electrical Code).

B. UL (Underwriters' Laboratories Inc.)

C. IEEE (Institute of Electrical and Electronics Engineers, Inc.)

1.4 ACTION SUBMITTALS

A. Section 01 33 00 – Contractor Submittals.

B. Product Data: Provide catalogue data for nameplates, labels, and markers.

1.5 INFORMATIONAL SUBMITTALS

A. Section 01 33 00 – Contractor Submittals.

B. Installation Data: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.6 MAINTENANCE SUBMITTALS

A. Section 01 78 23 - Operation and Maintenance Data and Manuals

PART 2 -- GENERAL

2.1 DESCRIPTION

A. REGULATORY REQUIREMENTS

1) Provide products listed and classified by UL as suitable for purpose specified and shown.

2.2 NAMEPLATES AND LABELS

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Locations:

1) Each electrical distribution and control equipment enclosure.

2) Communication cabinets.

C. Letter Size

1) Use (3 mm) letters for identifying individual equipment and loads.

2) Use (6 mm) letters for identifying grouped equipment and loads.

D. Labels: Embossed adhesive tape, with (5mm) white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations.

E. Clearly identify switchboards, power distribution centers, cable tray, power panels, distribution panels, lighting panels, disconnect switches, starters, contactors, motor control centers, low voltage terminal cabinets, junction boxes, remote On / Off switches, selector switches, light switches, receptacles, and transformers by permanent nameplates described below.

F. Panels: Identify the panels as shown on drawings and the main voltage

G. Transformers: Show capacity, primary and secondary voltages, identify the transformer as show on drawings

H. Disconnects, starters, and contactors: indicate equipment being controlled and voltage

I. Terminal cabinets and pull boxes: indicate the system and the voltages

J. Remote On /Off switches: indicate selector switch position functions

K. Motor Control Centers: identify distribution center as shown on drawings and the main voltage

L. Cable tray identified to voltage being carried in part of tray

M. Light switches to area being controlled

N. Provide nameplates of lamicoid plastic, white background with 10 mm black letters beveled edges and two mounting screw holes, mounted in conspicuous locations on the surface of the equipment, except in finished areas locate nameplates in flush panels mounted on panel front inside enclosure

O. Provide a complete list of nameplates for review by the Consultant

P. Provide on each receptacle a lamicoid label as defined in 2.1.3 stating the panel and circuit number, i.e., A-21B - Panel ‘A’, circuit number 21B.

Q. Provide neatly type circuit directories in panel boards to indicate the area or equipment controlled by each branch circuit.

2.3 WIRE MARKERS

A. Provide plastic, hot stamped wire marker on all conductor terminations.

B. Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and at each load connection.

C. Legend

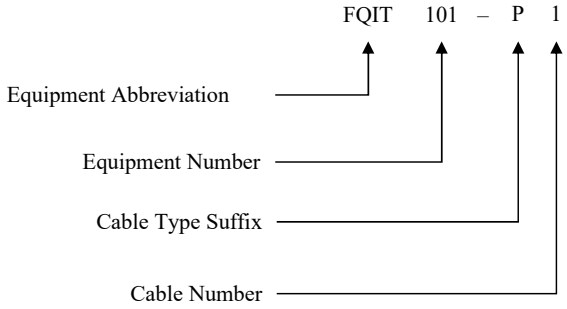
1) Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.

2) Control Circuits: Control wire number indicated on schematic and interconnection diagrams on Drawings.

2.4 CONDUIT MARKERS

A. All cable and conduit for electrical systems to be identified within 200 mm of exiting panel locations, pull box locations, within 200 mm of where they enter or leave a room or non-accessible ceiling space, and 4 m on center within an area. Identification of cable and conduit to consist of lamicoid plastic, black background with 10 mm white letters beveled edges and two mounting holes for securing around the surface of the conduit or cable.

B. Cable and conduit identification shall use a designation as identified on the drawings using the following format:



Equipment Abbreviation:
Per the Process Symbol and Legends sheet

Cable Suffix Designation Letters:
P ~ Power
C ~ Control and Instrumentation
E ~ Element

2.5 COLOR CODING OF CONDUCTORS

A. Conductors to be color coded throughout the building with the same color applying to same phase throughout. Color coding to be by insulation color or permanently applied color banding at all distribution centers and panels. Color coding to be as follows:

1) Equipment grounding conductor - green.

2) Neutral/Identified conductor - white.

3) 120/208 V phase wires - red, black, and blue.

4) 480 V - phase wires - red, black, and blue, or for larger conductor sizes, black with red, black, blue, colored tape.

5) At all distribution centers, pull boxes, wireways, etc., feeder conductors of each feeder group to be neatly laced or clipped into a feeder group with each conductor identified as to load fed.

6) At all pull boxes, junction boxes, and device outlet box locations; identify each conductor as to panel and circuit, i.e.., panel A circuit 23B - identify as A-23B using hot stamped heat shrink wire markers

PART 3 -- EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate and label parallel to equipment lines.

B. Secure nameplate to equipment front using screws, rivets, or adhesive.

C. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

D. Identify underground conduits using underground warning tape. Install one (1) tape per trench at (75 mm) below finished grade.

END OF SECTION

SECTION 26 05 73.13 - SHORT-CIRCUIT STUDIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.

2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

    a. Short-circuit study input data, including completed computer program input data sheets.

    b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

        1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

        2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.

2. For Power System Analysis Specialist.

3. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

2. The following are from the Short-Circuit Study Report:

    a. Final one-line diagram.

    b. Final Short-Circuit Study Report.

    c. Short-circuit study data files.

    d. Power system data.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.

2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.

2. A member company of NETA.

3. Acceptable to authorities having jurisdiction.

PART 2 -- PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.

2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings.

4. Motor and generator designations and kVA ratings.

5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.

6. Derating factors and environmental conditions.

7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.

2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.

3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.

5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.

2. Power sources available.

3. Manufacturer, model, and interrupting rating of protective devices.

4. Conductors.

5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.

    b. Calculated fault-current magnitude and angle.

    c. Fault-point X/R ratio.

    d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.

    b. Calculated symmetrical fault-current magnitude and angle.

    c. Fault-point X/R ratio.

    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.
        3) Based on calculated symmetrical value multiplied by 2.7.

    e. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

        1) Voltage.
        2) Calculated symmetrical fault-current magnitude and angle.
        3) Fault-point X/R ratio.
        4) No AC Decrement (NACD) ratio.
        5) Equivalent impedance.
        6) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
        7) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 -- EXECUTION

3.1 Power System Data

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.

2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices 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. Obtain electrical power utility impedance at the service.

3. Power sources and ties.

4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.

7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.

9. Motor horsepower and NEMA MG 1 code letter designation.

10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).

11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION

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SECTION 26 05 73.16 COORDINATION STUDIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and re-installed. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.

2. Submit the following after the approval of system protective devices submittals. Submittals shall be in digital form.

   a. Coordination-study input data, including completed computer program input data sheets.

   b. Study and equipment evaluation reports.

      1) Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

B. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Software Developer.

2. For Power Systems Analysis Specialist.

3. For Field Adjusting Agency.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. The following are from the Coordination Study Report:

   a. Final one-line diagram.

   b. Final protective device coordination study.

   c. Coordination study data files.

   d. List of all protective device settings.

   e. Time-current coordination curves.

   f. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.

2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.

2. A member company of NETA.

3. Acceptable to authorities having jurisdiction.

PART 2 -- PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Comply with IEEE 242 and IEEE 399.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of 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 and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

D. Optional Features:

1. Arcing faults.

2. Simultaneous faults.

3. Explicit negative sequence.

4. Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.
    a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
    a. Phase and Ground Relays:
        1) Device tag.
        2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
        3) Recommendations on improved relaying systems, if applicable.
    b. Circuit Breakers:
        1) Adjustable pickups and time delays (long time, short time, and ground).
        2) Adjustable time-current characteristic.
        3) Adjustable instantaneous pickup.
        4) Recommendations on improved trip systems, if applicable.
    c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.

2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

4. Plot the following listed characteristic curves, as applicable:

   a. Power utility's overcurrent protective device.

   b. Medium-voltage equipment overcurrent relays.

   c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.

   d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.

   e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.

   f. Cables and conductors damage curves.

   g. Ground-fault protective devices.

   h. Motor-starting characteristics and motor damage points.

   i. Generator short-circuit decrement curve and generator damage point.

   j. The largest feeder circuit breaker in each motor-control center and panelboard.

   k. Maintain selectivity for tripping currents caused by overloads.

   l. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.

   m. Provide adequate time margins between device characteristics such that selective operation is achieved.

   n. Comments and recommendations for system improvements.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

   1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.

2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other 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 power utility impedance at the service.

3. Power sources and ties.

4. Short-circuit current at each system bus (three phase and line to ground).

5. Full-load current of all loads.

6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.

8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.

a. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.

b. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.

c. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.

d. Maximum demands from service meters.

e. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.

f. Motor horsepower and NEMA MG 1 code letter designation.

g. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

h. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

i. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

1) Special load considerations, including starting inrush currents and frequent starting and stopping.

2) Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

3) Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

4) Generator thermal-damage curve.

5) Ratings, types, and settings of utility company's overcurrent protective devices.

6) Special overcurrent protective device settings or types stipulated by utility company.

7) Time-current-characteristic curves of devices indicated to be coordinated.

8) Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

9) Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

10) Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.

11) Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.

2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

2. Inrush current when first energized.

3. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

4. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

H. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

I. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.

2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

J. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

K. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

L. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

M. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

N. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.

2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.

1. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
2. Include in the report identification of any protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.

2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.

3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

B. MOTOR-STARTING STUDY

1. Perform a motor-starting study to analyze the transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of motor starting on the power system stability.

3.5 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with [short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.

2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.

3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION

SECTION 26 05 73.19 – Arc-Flash Hazard Analysis

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals [**shall**] [**may**] be in digital form:

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

G. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 -- PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

C. Executive summary of study findings.

D. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

E. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

F. Study Input Data: As described in "Power System Data" Article.

G. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

H. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

I. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

J. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

K. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

L. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch (76-by-127-mm) self-adhesive equipment label for each work location included in the analysis.

M. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

a. Arc-flash boundary.
b. Restricted approach boundary.
c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.

6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

N. Labels shall be machine printed, with no field-applied markings.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis[or obtain results from another source.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.
3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

F. Calculate the limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are

interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other 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. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Medium voltage transformers
6. Low voltage transformers. Exclude transformers with high voltage side 240 V or less and less than 125 kVA.
7. Panelboard and safety switch over 250 V.
8. Applicable panelboard and safety switch under 250 V.
9. Control panel.
10. <Insert equipment>.

C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION

SECTION 26 06 83 – WIRING CONNECTIONS

PART 1 --GENERAL

1.1 SECTION INCLUDES

A. Electrical connections to equipment specified under other sections.

1.2 RELATED REQUIREMENTS

A. Section 01 11 00 - Summary of Work.

B. Section 26 05 19 – Wire and Cabling.

C. Section 26 05 33 – Electrical Raceway Systems

1.3 REFERENCE STANDARDS

A. NEC (National Electrical Code)

B. UL (Underwriters Laboratories Inc.)

C. IEEE (Institute of Electrical and Electronics Engineers, Inc.)

1.4 ADMINISTRATIVE REQUIREMENTS

A. Section 01 31 00 – Project Coordination.

B. Coordination:

1. Coordinate with other work having a direct bearing on work of this section.

2. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.

3. Determine connection locations and requirements.

C. Sequencing:

1. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.

2. Sequence electrical connections to coordinate with start-up schedule for equipment.

1.5 ACTION SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.

1.6 INFORMATIONAL SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Installation Data: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

PART 2 -- PRODCUTS

2.1 DESCRIPTION

A. Regulatory Requirements:

1. Provide products listed and classified by UL as suitable for purpose specified and shown.

2.2 MATERIALS

A. Pressure type wire connectors: with current carrying parts of copper or copper alloy sized to fit copper conductors as required.

B. Fixtures type splicing connectors: with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.

C. Connectors: Tin plated Burndy, or equal, copper short barrel, one hole, compression type sized to suit copper conductor required for 600 Volt, 3 phase power terminations.

2.3 CORDS AND CAPS

A. Attachment Plug Construction: Conform to NEMA WD 1.

B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.

C. Type SJO (hard usage) cord type.

D. Cord Construction: NFPA 70, NEC, Type SO, SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.

E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit over-current protection.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

A. Make electrical connections to equipment manufacturer's written instructions.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.

C. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.

E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

F. Install disconnect switches, controllers, control stations, and control devices as indicated.

G. Modify equipment control wiring with terminal block jumpers as indicated.

H. Provide interconnecting conduit and wiring between devices and equipment where indicated.

I. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

J. Remove insulation carefully from ends of conductors and:

K. Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer.

END OF SECTION

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SECTION 26 09 13 – ELECTRICAL POWER MONITORING

PART 1 -- General

1.1 SUMMARY

A. Section Includes:
   1. Power meters.

1.2 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the RMS value of the voltage, and "I" is the RMS value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. L-G: Line to ground.

H. L-L: Line to line.

I. L-N: Line to neutral.

J. MODBUS TCP/IP: An open protocol for exchange of process data.

K. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

L. N-G: Neutral to ground.

M. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

    a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:

        1) Location of the meters and gateways, and routing of the connecting wiring.
        2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.
5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.
7. UPS sizing calculations for workstation.
8. Surge Suppressors: Data for each device used and where applied.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

    a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
    b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
    c. As-built versions of submittal Product Data.
    d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
    e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.

f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
m. Owner training materials.

1.5 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 – Products

2.1 POWER METERS

A. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

E. Data Link:

1. Ethernet I/P

F. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least [**four**] <**Insert number**> lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display must include the following:

a. Meters, including those listed under the following:

1) Measurements.
2) THD.
3) Energy.
4) Demand.
5) Minimum and maximum values.
6) Power demand.

G. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle simultaneously on voltage and current channels of the meter.

H. Meters:

1. Measurements: Instantaneous, in real time, RMS to the 15th harmonic.

a. Voltage: L-L each phase, L-N each phase, and three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Unbalanced current, L-L V(ac) and L-N V(ac).
d. Active Power (+/- kW): Each phase and three-phase total.
e. Reactive Power (+/- kVAR): Each phase and three-phase total.
f. Apparent Power (+/- kVA): Each phase and three-phase total.
g. Displacement Power Factor: Each phase and three-phase total.
h. Distortion Power Factor: Each phase and three-phase total.

i. Frequency.

2. THD from measurements simultaneously from the same cycle, through 15th harmonic.

   a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
   b. Current THD: Each phase and three-phase average.
   c. Total demand distortion.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

   a. Active kWh.
   b. Reactive kVARh.
   c. Apparent kVAh.

4. Demand: Present, last, predicted, peak.

   a. Three-phase average current.
   b. Three-phase total active power (kW).
   c. Reactive power (kVAR).
   d. Apparent power (kVA).

5. Minimum and Maximum Values:

   a. L-L and L-N voltages.
   b. Current in each phase.
   c. Power factor.
   d. Active power total.
   e. Reactive power total.
   f. Apparent power total.
   g. THD L-L and L-N voltages.
   h. THD current in each phase.
   i. Frequency.

I. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

   a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
   b. Fixed block that calculates demand at end of the interval.
   c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation must be configurable as either a block or rolling block calculation.
b. Signal is a communication signal. Calculation must be configurable as either a block or rolling block calculation.
c. Provide for synchronizing the demand with the internal of this instrument.

J. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Minimum and maximum of real-time RMS measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

K. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm must be user configured, by using the following options:

1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

L. Output Signals: Provide two mechanical relays, rated not less than 250 V(ac), 2 A resistive, and rated for 200,000 cycles or more. The relays must be user configurable in one of the following listed modes:

1. Normal contact closure where the contacts change state for as long as the signal exists.
2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

M. Meter Face:

1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

N. Capacities and Characteristics:

1. Power Supply: 480V
2. Circuit Connections:

a. Voltage: Measurements autoranging, 60 to 400 V(ac) L-N.[Connect directly to low-voltage (600 V and less) without using voltage transformers.

Connect to instrument grade potential transformers secondary at 120 V. Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.

b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

PART 3 -- Execution

3.1 INSTALLATION OF POWER MONITORING AND CONTROL SYSTEMS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Wiring and Cabling Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.

D. Raceways Installation:

1. Comply with Section 260533 "Raceway and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, TIA-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

E. Identification Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, TIA-485 cable, control-voltage cable, and TIA-232 cable.
3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

F. For data communication wiring, comply with BICSI N1.

G. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of components.
4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5. Power Monitoring and Control System Tests.

    a. Test Analog Signals:

        1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
        2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
        3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

    b. Test Digital Signals:

        1) Check digital signals using a jumper wire.
        2) Check digital signals using an ohmmeter to test for contact making or breaking.

    c. I/O Control Loop Tests:

        1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.

2) Test every I/O point throughout its full operating range.
3) Test every control loop to verify that operation is stable and accurate.
4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5) Test and adjust every control loop for proper operation according to sequence of operation.
6) Test software and hardware interlocks for proper operation.
7) Operate each analog point at the following:

    a) Upper quarter of range.
    b) Lower quarter of range.
    c) At midpoint of range.

8) Exercise each binary point.
9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument must match.
10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.3 FINAL REVIEW

A. When the power monitoring and control system is ready for final review. Written request must state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.

C. Final review must include a demonstration to parties participating in final review.

3.4 DEMONSTRATION

A. Demonstration must include, but not be limited to, the following:

1. Accuracy and calibration of I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.

2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.
7. Step through penetration tree, display graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:

    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

END OF SECTION

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1. Photoelectric switches.
2. Indoor occupancy sensors.
3. Lighting contactors.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 -- PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Fifteen second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.

5. Mounting: Twist lock complies with NEMA C136.10, with base and stem mounting, or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Lutron Electronics Co., Inc.
4. Sensor Switch, Inc.
5. Watt Stopper.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with an integral or separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2- to 200 fc (21.5- to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
3. Lutron Electronics Co., Inc.
4. Sensor Switch, Inc.
5. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR or Dual technology - PIR and ultrasonic.
3. Switch Type: SP or SP, dual circuit.
4. Voltage: Match the circuit voltage.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.

7. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 LIGHTING CONTACTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ASCO Power Technologies, LP; a division of Emerson Electric Co.
2. Eaton Corporation.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
4. Square D; a brand of Schneider Electric.

B. Description: Electrically operated and mechanically- held lighting contactors complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide cover-mounted control and pilot devices matching the NEMA type specified for the enclosure, as follows:

a. LED red pilot light to indicate “ON” status.
b. Hand-Off-Auto selector switch.

5. Control Circuit Description:

a. Two-wire control interface.
b. Power source: External 120VAC unless otherwise indicated.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables".

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables".

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 23 "Control-Voltage Electrical Power Cables".

PART 3 -- EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

C. Adjust occupancy sensors to the following time settings, unless otherwise indicated on drawings:
1. Restrooms: 15 minutes.
2. Locker rooms: 15 minutes.
3. Offices: 10 minutes.
4. storage rooms: 5 minutes.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables".

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 12 16 – PANELBOARDS AND GENERAL-PURPOSE DRY TYPE TRANSFORMERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide panelboards and general-purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. **Single Manufacturer:** Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 CONTRACTOR SUBMITTALS

A. **General:** Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals and Section 26 00 00 - Electrical Work, General.

B. Shop Drawings

1. Transformers

a. Dimension drawings
b. Technical certification sheets
c. Drawing of conduit entry/exit locations
d. Transformer ratings, including:

1) Voltage
2) Continuous current
3) Basic impulse level for equipment over 600 volts
4) kVA

e. Descriptive bulletins
f. Product sheets

2. Panelboards

a. Breaker layout drawings with dimensions and nameplate designations
b. Component list
c. Drawings of conduit entry/exit locations
d. Assembly ratings including:

1) Short circuit rating
2) Voltage
3) Continuous current

e. Cable terminal sizes
f. Descriptive bulletins
g. Product sheets
h. Installation information
i. Seismic certification and equipment anchorage details

PART 2 -- PRODUCTS

2.1 GENERAL

A. Transformers

1. The transformers shall be dry-type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.

2. Transformers shall be UL-listed and bear the UL label.

B. Panelboards

1. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208 volt, 3 phase operation or 120/240 volt for single phase operation as indicated. Power panelboards shall be rated for 480 volts, 3 phase, 3 wire operation.

2. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

2.2 TRANSFORMERS

A. **Energy Efficiency**: Standard dry-type transformers shall meet the energy efficiency requirements of NEMA TP-1 and the Department of Energy Code of Federal Regulations (10 CFR PART 431). The product requirements are in the appliance regulations, Title 20, and the usage requirements are in Title 24.

B. Ratings

1. kVA and voltage ratings shall be as indicated.

2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers

3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up to 9 kVA	40 db
10 to 50 kVA	45 db
51 to 150 kVA	50 db

C. Construction

1. Insulation Systems

a. Transformers shall be insulated as follows:

1) 2 kVA and smaller: 150 deg C insulation system based upon 80 deg C rise.

2) 3 to 15 kVA: 185 deg C insulation system based upon 115 deg C rise.

3) 15 kVA and larger: 220 deg C insulation system based upon 150 deg C rise.

b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 deg C maximum ambient.

c. Insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

2. Transformer windings shall be copper.

3. Transformers shall have four 2-1/2 percent taps, 2 above and 2 below 480 volts.

4. Type 12 for indoor transformers.

5. Type 3R stainless steel/Type 4X for outdoor transformers.

D. Manufacturers: Transformers shall be floor or wall-mounted type by General Electric, Eaton Electrical, Square D, or equal.

2.3 PANELBOARDS

A. Ratings

1. Panelboards rated 240 VAC or less shall have short circuit ratings not less than 10,000 amperes RMS symmetrical or as indicated by the Contract Drawings, whichever is greater.

2. Panelboards rated 480 VAC shall have short circuit ratings not less than 42,000 amperes RMS symmetrical or as indicated by the Contract Drawings, whichever is greater.

3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

B. Construction

1. Lighting and power distribution panels shall have copper busbars.

2. Breakers shall be one, 2, or 3 pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.

3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals

and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

4. Panelboards shall be rated for the intended voltage.

5. Circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.

6. Lighting and power distribution panels which are not part of a motor control center shall be constructed in accordance with Section 26 00 00. Panels shall have the necessary barriers, supports, and liberal wiring gutters. Trim screws shall be stainless steel. Panelboard parts of metal other than copper, aluminum, or stainless steel shall be cadmium plated. Panelboards shall be as manufactured by General Electric or Eaton Electrical.

7. Panelboards shall be UL listed except for special enclosures which are not available with UL listing.

8. Panelboards shall be suitable for use as service entrance where indicated.

9. Type 12 for panelboards installed indoors.

10. Type 3R Stainless Steel/Type 4X for panelboards installed outdoors.

11. Main breaker for panelboard or load center where shown on the drawings.

12. Panelboards to be lockable.

C. Surge Protective Devices

1. Surge Protective Devices (SPD) shall be designed to provide transient voltage protection for a service entrance panelboard.

2. SPD units shall comply with UL 1449 4th Edition, and shall be listed for such use.

3. Lighting and power distribution panels shall have SPD units installed as part of the panelboard or close-coupled to the panelboard.

4. SPD units shall be rated for the voltage and phase service of the panel at 120 kA per phase.

5. SPD units shall have a built-in diagnostic package with flashing trouble indicator, a display for the status of each phase, and a counter and display to indicate the number of surges that have caused the device to operate.

PART 3 -- EXECUTION

3.1 PANELBOARDS

A. GENERAL

1. WORK of this Section shall be installed as indicated in Section 26 00 00.

B. EXAMINATION

1. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

2. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

3. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

4. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

C. INSTALLATION

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

2. Comply with NECA 1.

3. Install panelboards and accessories according to NEMA PB 1.1.

4. Equipment Mounting:

   a. Attach panelboard to the vertical finished or structural surface behind the panelboard.

   b. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

5. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

6. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

7. Mount top of trim 72 inches above finished floor unless otherwise indicated.

8. Mount panelboard cabinet plumb and rigid without distortion of box.

9. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

10. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

11. Install overcurrent protective devices and controllers not already factory installed.

a. Set field-adjustable, circuit-breaker trip ranges.

b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

12. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

13. Install filler plates in unused spaces.

D. IDENTIFICATION

1. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

2. Create a directory to indicate installed circuit loads (after balancing panelboard loads); incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

4. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

5. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

E. FIELD QUALITY CONTROL

1. Perform tests and inspections.

2. Acceptance Testing Preparation:

a. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

b. Test continuity of each circuit.

3. Tests and Inspections:

a. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers (and low-voltage surge arrestors) stated in NETA ATS, Paragraph 7.6 Circuit Breakers (and Paragraph 7.19.1 Surge Arrestors, Low-Voltage). Perform optional tests. Certify compliance with test parameters.

b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

c. Perform the following infrared scan tests and inspections and prepare reports:

a) Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.

b) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

c) Instruments and Equipment:

(a) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Panelboards will be considered defective if they do not pass tests and inspections.

5. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. ADJUSTING

1. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

2. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

a. Measure loads during period of normal facility operations.

b. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

c. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.

d. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

G. PROTECTION

1. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 TRANSFORMERS

A. EXAMINATION

1. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

2. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

3. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

4. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

5. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

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

B. INSTALLATION

1. Install wall-mounted transformers level and plumb with wall brackets fabricated [by transformer manufacturer from design drawings signed and sealed by a licensed structural engineer.

   a. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

   b. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

2. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

3. Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

   a. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

4. Secure transformer to concrete base according to manufacturer's written instructions.

5. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

6. Remove shipping bolts, blocking, and wedges.

C. CONNECTIONS

1. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

2. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

4. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

D. FIELD QUALITY CONTROL

1. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

a) Inspect physical and mechanical condition.

b) Inspect anchorage, alignment, and grounding.

c) Verify that resilient mounts are free and that any shipping brackets have been removed.

d) Verify the unit is clean.

e) Perform specific inspections and mechanical tests recommended by manufacturer.

f) Verify that as-left tap connections are as specified.

g) Verify the presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

c. Measure resistance at each winding, tap, and bolted connection.

d. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.

e. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.

f. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. ADJUSTING

1. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

2. Output Settings Report: Prepare a written report recording output voltages and tap settings.

F. CLEANING

1. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 23 03 – ENCLOSED SWITCHES

PART 1 -- General

1.1 SECTION INCLUDES

A. Fusible switch assemblies.

B. Non-fusible switch assemblies.

1.2 REFERENCE STANDARDS

A. NEC (National Electrical Code)

B. NEMA FU 1-2012 - Low Voltage Cartridge Fuses.

C. NETA ATS-2017 - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

D. UL (Underwriters Laboratories Inc.)

1.3 ACTION SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Product Data: Provide switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

A. Record Documentation: Record actual locations of enclosed switches in project record documents.

1.5 QUALITY ASSURANCE

A. Products of This Section: Manufactured to ISO 9000 and ISO 14000 certification requirements.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

PART 2 -- Products

2.1 DESCRIPTION

A. Regulatory Requirements:

1. Products: Listed and classified by UL as suitable for the purpose specified and indicated.

2.2 FUSIBLE SWITCH ASSEMBLIES

A. Fusible Switches: Type 12 (indoor) / Type 4X (outdoor) with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch.

B. Handle lockable in OFF position.

C. Fuse clips: Designed to accommodate NEMA FU 1, Class J fuses.

2.3 NON-FUSIBLE SWITCH ASSEMBLIES

A. Non-Fusible Switches: Type 12 (Indoor) / Type 4X (outdoor) with externally operable handle interlocked to prevent opening front cover with switch in ON position, enclosed load interrupter knife switch.

B. Handle lockable in OFF position.

C. Non-fusible switch assemblies for Raw Sewage and Sump Pump applications.

2.4 ENCLOSURES

A. Enclosures:

B. Interior Dry Locations: Type 12.

C. Exterior Locations: Type 4X.

PART 3 -- Execution

3.1 INSTALLATION

A. Install to NEC.

B. Install fuses in fusible disconnect switches.

C. Apply adhesive tag on inside door of each fused switch indicating UL fuse class and size installed.

3.2 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Section 01 45 00: Quality Control.

2. Perform inspections and test listed in NETA ATS.

END OF SECTION

SECTION 26 23 04 - DISCONNECT SWITCHES

PART 1 -- GENERAL

1.1 RELATED REQUIREMENTS

A. Section 26 05 00 – Common Work Results – Electrical

1.2 REFERENCE STANDARDS

A. NEC (National Electrical Code)

B. UL (Underwriter's Laboratories Inc.)

C. IEEE (Institute of Electrical and Electronics Engineers, Inc.)

1.3 ACTION SUBMITTALS

A. Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Printed product literature and data sheets for disconnected switches.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data.

B. Final as-built drawings and information.

PART 2 -- PRODUCTS

2.1 DISCONNECT SWITCHES

A. General description

1. Provide non fusible disconnect switch, with rating as noted.

2. Switch mechanisms:

a. Quick make a quick break action with self-wiping contacts, solderless pressure lug connectors.

b. For switches 100 A and over, provide non-tracking arc shrouds.

c. All switch poles to operate together from a common operating bar.

d. Provide for padlocking disconnect switches in OFF position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handling in ON position.

e. For vendor pump systems with power cables complete with integral controls cables, provide terminals disconnect switches for connection of control wires.

3. Neutral Bars:

a. Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

4. ON / OFF switch position indication on switch enclosure cover.

5. Equipment ground shall be factory installed.

6. NEMA Type 4X (316 Stainless Steel), wall mounted enclosures for outdoor switches.

7. NEMA Type 12, wall mounted enclosures for indoor switches.

8. Heavy Duty with amperage ratings shown in the detailed design.

9. Disconnect switches to be HP rated for all motor applications.

10. Lug connections sized as required for conductors shown in the drawings.

11. Disconnect switches shall be UL compliant for service equipment.

2.2 MAIN DISCONNECT & UTILITY METERING

A. Combined utility CT metering section and main disconnect:

1. Utility Metering Section: 1-CT-U

2. Main Disconnect Section: 5-DS-01

B. Main Disconnect

1. Service: 480Y/277V, 3-Phase, 4-Wire

2. Service entrance rated

3. Bus Amps: 1000A

4. Neutral Amps: 1000A

5. Bus Material: Copper

6. Ground Bus Material: Copper ground bus bolted to frame

7. Terminals, Mechanical, Bottom (Refer to PUD requirements)

8. Minimum Interrupt Rating: 65kA

9. (4) 4/0-500 kcmil (L1,L2,L3,N) Incoming and outgoing

10. LSIG Trip Unit w/ARMS

11. 1000AFR, 900AT

12. UL 1773

C. Utility Metering Section:

1. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers, or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
2. 1000A utility metering compartment
3. Vertical Isolation Barrier (Service Entrance)
4. Horizontal Isolation Barrier (Service Entrance)
5. (4) 4/0-500 kcmil (L1,L2,L3,N) Incoming and outgoing
6. Meter Door
7. Doors (2) 15” Blank Doors
8. Seismic Label (IBC/CBC Seismic Qualified) – Freestanding
9. Minimum Interrupt Rating: 65kA

D. Dimensions: Limiting for combined 5-DS-01 and 1-CT-U

1. Width 78”
2. Height: 90”
3. Depth: 30”

2.3 CUSTOMER METERING

A. General:

1. Customer Metering Section: 5-CT-01
2. Seismic Label (IBC/CBC Seismic Qualified) – Freestanding
3. Bussed structure for incoming and outgoing cables
4. Section 1: Pull Section – MLO
5. Section 2: Customer Metering
6. (4) 4/0-500 kcmil (L1,L2,L3,N) Incoming and outgoing
7. 480Y/277V, 3-Phase, 4-Wire
8. 1000A
9. Minimum Interrupt Rating: 65kA

B. Dimensions: Limiting

1. Width 60”

2. Height: 90”

3. Depth: 30”

2.4 EQUIPMENT IDENTIFICATION

A. Provide equipment identification in accordance with Section 26 05 00 – Common Work Results – Electrical.

B. Indicate name of load controlled on size 4 nameplate.

C. Refer to drawings for additional details.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install on walls or on stands where shown on the electrical drawing package.

END OF SECTION

SECTION 26 24 13 – SWITCHBOARDS

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. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Instrumentation.
4. Control power.
5. Accessory components and features.
6. Identification.
7. CT structures

B. Related Requirements

1. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices where required.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Delegated Design Submittal:

1. For arc-flash hazard analysis.
2. For arc-flash labels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer

B. Seismic Qualification Data: Certificates, for switchboards, overcurrent protective devices, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. Routine maintenance requirements for switchboards and all installed components.

2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Handle and prepare switchboards for installation according to NECA 400 NEMA PB 2.1.

1.8 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding 104 deg F (40 deg C).
b. Altitude: Not exceeding 100 feet (25 m).

1.9 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.
2. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event

2.2 SWITCHBOARDS

A. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 2.

E. Comply with NFPA 70.

F. Comply with UL 891.

G. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

H. Nominal System Voltage: 480Y/277 V

I. Main-Bus Continuous: 1000A.

J. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Shake-table testing shall comply with ICC-ES AC156.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

K. Indoor Enclosures: Steel, NEMA 12 complete with ventilation

L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard finish over a rust-inhibiting primer on treated metal surface.

M. Outdoor Enclosures: Type 4x

1. Finish: Factory-applied finish in manufacturer's standard color; undersurfaces treated with corrosion-resistant undercoating.
2. Enclosure: Downward, rearward sloping roof; rear hinged doors for each section, with provisions for padlocking.
3. Doors: Personnel door at each end of aisle, minimum width of [30 inches (762 mm opening outwards; with panic hardware and provisions for padlocking. At least one door shall be sized to permit the largest single switchboard section to pass through without disassembling doors, hinges, or switchboard section.
4. Accessories: LED luminaires, ceiling mounted; wired to a three-way light switch at each end of aisle; ground-fault circuit interrupter (GFCI) duplex receptacle; emergency battery pack luminaire installed on wall of aisle midway between personnel doors.
5. Walk-in Aisle Heating and Ventilating:

a. Factory-installed electric unit heater(s), wall or ceiling mounted, with integral thermostat and disconnect and with capacities to maintain switchboard interior temperature of 40 deg F (5 deg C) with outside design temperature of 0 deg F (minus 18 deg C)
b. Factory-installed exhaust fan with capacities to maintain switchboard interior temperature of 100 deg F (38 deg C) with outside design temperature of [90 deg F (32 deg C).
c. Ventilating openings complete with replaceable fiberglass air filters.
d. Thermostat: Single stage; wired to control heat and exhaust fan.

6. Power for Space Heaters, Ventilation, Lighting, and Receptacle: Include a control-power transformer, with spare capacity of 25 percent, within the switchboard. Supply voltage shall be 120 Vac.
7. Power for space heaters, ventilation, lighting, and receptacle provided by a remote source.

N. Barriers: Between adjacent switchboard sections.

O. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

P. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.

1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point

2. Space-Heater Power Source: Transformer, factory installed in switchboard] [120-V external branch circuit.

Q. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

R. Utility Metering Compartment: See 26 24 13 “Switchboards and CT Metering”

S. Customer Metering Compartment: See 26 24 13 “Switchboards and CT Metering”

T. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

U. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

V. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Set back from front to clear circuit-breaker removal mechanism.
3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
4. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
5. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

W. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, (silver plated).
3. Copper feeder circuit-breaker line connections.
4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
5. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) 1/4-by-1-inch- (6-by-25-mm-) [Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
6. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
7. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.

8. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
9. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

X. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

Y. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.3 SURGE PROTECTION DEVICES

A. See 26 43 00, “Surge Protection Devices”.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long and short time adjustments.
    d. Ground-fault pickup level, time delay, and I squared t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).

B. Insulated-Case Circuit Breaker (ICCB): 100 percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. Fixed circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

2.5 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch- (0.813-mm-) thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

C. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

D. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

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

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

C. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

D. Support and secure conductors within the switchboard according to NFPA 70.

E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Acceptance Testing:

    a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION

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SECTION 26 72 36 – WIRING DEVICES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1. Standard-grade receptacles, 125 V, 20 A.
2. GFCI receptacles, 125 V, 20 A.
3. Twist-locking receptacles.
4. Pendant cord-connector devices.
5. Cord and plug sets.
6. Toggle switches, 120/277 V, 20 A.
7. Occupancy sensors.
8. Wall-box dimmers.
9. Wall plates.

1.2 RELATED DOCUMENTS

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

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 -- PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

G. Wall Plate Color: For plastic covers, match device color.

H. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with requirements in this Section.

F. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

G. Wall Plate Color: For plastic covers, match device color.

H. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.3 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:
   1. Description: Two pole, three wire, and self-grounding.
   2. Configuration: NEMA WD 6, Configuration 5-20R.
   3. Standards: Comply with UL 498 and FS W-C-596.

B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
   1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
   2. Configuration: NEMA WD 6, Configuration 5-20R.
   3. Standards: Comply with UL 498.

C. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:
   1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
   2. Configuration: NEMA WD 6, Configuration 5-20R.
   3. Standards: Comply with UL 498.

2.4 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:
   1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
   2. Configuration: NEMA WD 6, Configuration 5-20R.
   3. Type: Feed through.
   4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:
   1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
   2. Configuration: NEMA WD 6, Configuration 5-15R.
   3. Type: Feed through.
   4. Standards: Comply with UL 498 and UL 943 Class A.

2.5 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles, 250 V, 20 A:
   1. Configuration: NEMA WD 6, Configuration L6-20R.
   2. Standards: Comply with UL 498.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

C. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

D. connector.

E. Standards: Comply with FS W-C-596.

2.7 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:
   1. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A:
   1. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A:
   1. Comply with UL 20 and FS W-S-896.

D. Pilot-Light, Single-Pole Switches: 120/277 V, 20 A:
   1. Description: Illuminated when switch is on.
   2. Standards: Comply with UL 20 and FS W-S-896.

E. Key-Operated, Single-Pole Switches, 120/277 V, 20 A:
   1. Description: Factory-supplied key in lieu of switch handle.
   2. Standards: Comply with UL 20 and FS W-S-896.

2.9 OCCUPANCY SENSORS

A. Wall Switch Sensor Light Switch, Dual Technology:

   1. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
   2. Standards: Comply with UL 20.
   3. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.

4. Adjustable time delay of 5,10,15,20 minutes.
5. Able to be locked to Automatic-On mode.
6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
7. Connections: Integral wireless networking.

B. Wall Sensor Light Switch, Passive Infrared:
1. Description: Switchbox-mounted, combination, lighting-control sensor and conventional switch lighting-control unit using passive infrared technology.
2. Standards: Comply with UL 20.
3. Connections: Wireless.
4. Adjustable time delay of 20 minutes.
5. Able to be locked to Automatic-On mode.
6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.

2.10 DIMMERS

A. Wall-Box Dimmers:
1. Description: Modular, full-wave, solid-state dimmer switch with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
2. Control: Continuously adjustable rotary knob; with single-pole or three-way switching.
3. Standards: Comply with UL 1472.

2.11 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

3.2 GFCI RECEPTACLES

A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Tests for Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

D. Test straight-blade for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

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SECTION 26 28 13 - FUSES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

a. Control circuits.
b. Panelboards.
c. Switchboards.
d. Enclosed controllers.
e. Enclosed switches.

1.2 RELATED DOCUMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit [in electronic format suitable for use in coordination software.
4. Coordination charts and tables and related data.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. Include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than [40 deg F (5 deg C)] or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting, time delay.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC[, fast acting, time delay.
5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
7. Type T: 250-V, zero- to 1200-A 600-V, zero- to 800-A rating, 200 kAIC, very fast acting, time delay.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class J, fast acting Class J, time delay Class T, fast acting.
2. Feeders: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class RK5, fast acting Class RK5, time delay Class J, fast acting Class J, time delay.
3. Motor Branch Circuits: Class RK1 Class RK5 Class CC, motor duty, time delay.
4. Large Motor Branch (601-4000 A): Class L, time delay.
5. Power Electronics Circuits: Class J, high speed Class T, fast acting.
6. Other Branch Circuits: Class RK1, time delay Class RK5, time delay Class J, fast acting Class J, time delay Class CC, fast acting.
7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 26 29 23 – VARIABLE FREQUENCY DRIVE UNITS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General

1. The CONTRACTOR shall provide variable frequency drive (VFD) units, complete and operable, as indicated in accordance with the Contract Documents.

2. It is the intent of this Section to require complete, reliable, and fully tested variable frequency drive systems suitable for attended or unattended operation.

B. THE SUMMARY of Section 26 00 00 – Electrical Work, General, applies to the WORK of this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services.

2. This requirement, however, does not relieve the CONTRACTOR of overall responsibility for the WORK.

D. Coordination

1. Equipment provided under this Section shall operate the electric motor driver and the driven equipment as indicated under other equipment specification Sections.

2. The CONTRACTOR'S attention is specifically directed to the need for proper coordination of the WORK under this Section and the WORK under the equipment Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with THE SUMMARY of Section 01 33 00 – Contractor Submittals, except that Shop Drawing information for the drives shall be submitted as part of the information for the driven equipment.

B. Shop Drawings: Include the following information:

1. Equipment Information
   a. Name of drive manufacturer.
   b. Type and model.
   c. Assembly drawing and nomenclature.
   d. Maximum heat dissipation capacity in kW.

2. Conduit entrance provisions.

3. Circuit breaker type, frames, and settings.

4. Information related to any relays, timers, pilot devices, control transformer VA, and fuses used, including catalog cuts.

5. Ladder Diagram

   a. Submit the system schematic ladder diagram and interconnection diagrams.

   b. The schematic ladder diagram shall include remote devices.

   c. The ladder diagram shall incorporate the control logic on the corresponding elementary schematic as indicated.

   d. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the CONTRACTOR stamped "REJECTED."

6. Factory test data certifying compliance of similar equipment from the same manufacturer with requirements of this Section.

C. The Technical Manual shall include the following documentation:

1. Manufacturer's 2-year warranty.
2. Field test report.
3. Programming procedure and program settings.

D. Spare Parts List

1. Submit information for parts required by this Section plus any other spare parts recommended by the controller manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The CONTRACTOR shall provide variable frequency drives as indicated in the Contract Drawings.

2.2 EQUIPMENT

A. General

1. The power supply shall be an adjustable frequency inverter designed to convert incoming 3-phase, 480-volt, 60-Hertz power to a DC voltage and then to adjustable frequency AC by use of a 3-phase inverter.

2. Current-source inverters will not be accepted.

3. Inverters shall be sized to match the kVA and inrush characteristics of the motors actually provided.

4. The CONTRACTOR shall be responsible for matching the controller to the load (variable torque or constant torque) as well as the speed and current of the actual motor being controlled.

B. Inverter

1. The inverter shall be of a voltage-source design, producing a pulse-width-modulated type output.

2. Motors shall be provided in accordance with Section 26 05 10 – ELECTRIC MOTORS.

3. Inverters shall be capable of delivering the nameplate horsepower exclusive of service factor without the need for mandatory thermostats or feedback tachometers.

4. The VFD shall vary both the AC voltage and frequency simultaneously in order to operate the motor at required speeds.

C. The minimum VFD inverter efficiency shall be 95 percent at 100 percent speed and load, and 85 percent efficiency at 50 percent speed and load.

D. Power Outage

1. The VFD shall shut down in an orderly manner when a power outage occurs on one or more phases.

2. Upon restoration of power and a START signal, the motor shall restart and run at the speed corresponding to the current process input signal. The START signal shall not need to recycle to restart the motor.

E. The VFD shall be provided with the following features:

1. Inrush current adjustment between 50 and 110 percent of motor full load current (factory set at 100 percent).

2. Overload capability at 110 percent for 60 seconds for variable torque loads and 150 percent for constant torque loads.

3. Adjustable acceleration and deceleration.

4. Input speed command signal over the Ethernet communications from the plant PLC (Programmable Logic Controller).

5. Output speed signal over the Ethernet communications to the plant PLC.

6. Upon loss of input signal, the VFD shall operate at an operator adjustable preset speed.

7. A minimum of 2 selectable frequency jump points in order to avoid critical resonance frequency of the driven system.

8. Additional devices and functions as indicated.

9. Ethernet communications with the protocol required to transmit VFD data to/from a plant PLC-based control system.

F. The VFD shall be provided with, as a minimum, the following protection features:

1. Input line surge protection.
2. Protection against single phasing.
3. Instantaneous overcurrent protection.
4. Electronic overcurrent protection.
5. Ground fault protection.
6. Overtemperature protection for electronics.
7. Protection against internal faults.
8. Ability to start into rotating motor (forward or reverse rotation).
9. Additional protection and control as indicated and as required by the motor and driven equipment.

G. The VFD shall be designed and constructed to satisfactorily operate within the following service conditions.

1. Elevation – the site elevation is less than 200 feet above MSL.
2. Ambient Temperature: 0 to 40 degrees C.
3. Humidity: 0 to 95 percent, non-condensing.
4. AC Line-Voltage Variation: plus 10 percent to minus 10 percent.
5. AC Line-Frequency Variation: plus and minus 2 Hertz.

H. Inverter Signal Circuits

1. The inverter shall communicate with the plant controller using the data protocol shown on the Contract Drawings.
2. The inverter shall be provided with the data communications modules and terminations equipment for the data cable.

I. Properly identified screw type terminal boards shall be provided for interconnection to remote controls and instrumentation

J. Pilot devices, control relays, time delay relays, elapsed time meters, and indicators provided as a part of the VFD equipment package shall meet the applicable requirements of Section 26 05 15 – INDUSTRIAL CONTROL PANELS.

2.3 SPARE PARTS

A. The CONTRACTOR shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.

B. Modified Parts

1. At any time prior to Substantial Completion, the CONTRACTOR shall notify the ENGINEER in writing about any manufacturer's modification of spare part numbers, interchangeabilities, or model changes.

2. If the ENGINEER determines that the modified parts no longer apply to the equipment provided, the CONTRACTOR shall furnish other applicable parts as part of the WORK.

C. The following spare parts shall be furnished:

1. Provide one set of spare power fuses of each form, voltage, and current rating.

2. Provide 10 spare control and power fuses of each type and rating.

3. Provide one set of any special tools required for maintenance of the VFD units.

2.4 Manufacturers, or equal

A. **Eaton Electrical**

B. **Allen-Bradley**

C. **Siemens/Robicon**

D. **Schnieder**

PART 3 -- EXECUTION

3.1 MANUFACTURER'S SERVICES

A. General

1. An authorized service representative of the manufacturer shall be present at the Site for 1 Day to furnish the services listed below.

2. For the purpose of this Paragraph, a Day is defined as an 8-hour period excluding travel time.

B. The authorized service representative shall supervise the following and shall certify that the equipment and controls have been properly installed, aligned, and readied for operation:

1. Installation of the equipment.

2. Configuring the drive communications to communicate with the plant controller.

3. Inspection, checking, and adjusting the equipment.

4. Startup and field testing for proper operation.

5. Performing field adjustments such that the equipment installation and operation comply with requirements.

C. Instruction of OWNER's Personnel

1. The authorized representative shall instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with test equipment.

2. The instruction shall be specific to the VFD models provided.

3. Training shall be scheduled a minimum of 1 week in advance of the first session.

4. Training shall include individual sessions for 1 shift of plant personnel.

5. Proposed training materials shall be submitted for review, and comments shall be incorporated.

6. Training materials shall remain with the trainees.

7. The OWNER may videotape the training for later use with the OWNER's personnel.

3.2 INSTALLATION

A. Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendations.

B. Programming

1. The CONTRACTOR shall perform programming of drive parameters required for proper operation of the VFDs included in this project.

2. Submit records of programming data in the equipment Technical Manual, including setup and protective settings.

3.3 FIELD TESTING

A. Testing, checkout, and startup of the VFD equipment in the field shall be performed under the technical direction of the manufacturer's service engineer.

B. Under no circumstances shall any portion of the drive system be energized without authorization from the manufacturer's representative.

C. Verify proper operation of control logic in every mode of control.

END OF SECTION

SECTION 26 32 13 - STANDBY POWER GENERATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide functional engine-driven standby electrical generating systems, complete and operable, in accordance with the Contract Documents.

B. The CONTRACTOR shall be responsible for coordination of interface with other equipment and for any special construction necessary to complete the WORK of this Section in an acceptable manner.

C. Section Includes:

1. Engine-generator assembly.
2. Diesel engine.
3. Diesel fuel-oil system.
4. Control and monitoring.
5. Generator overcurrent and fault protection.
6. Alternator, exciter, and voltage regulator.
7. Load bank.
8. Outdoor engine generator enclosure.
9. Vibration isolation devices.
10. Finishes.
11. Generator platforms and stairs.

1.2 RELATED DOCUMENTS

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

B. Related Requirements:

1. Section 26 36 00 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Materials shall conform with applicable requirements of the National Electrical Code (NEC), and any other State or Municipal codes which apply. Generator system shall meet applicable standards and codes, including IEEE, NEMA, ANSI, OSHA, and UL.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Include thermal damage curve for generator.

3. Include time-current characteristic curves for generator protective device.

4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.

7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

a. Shop Drawings:

1) Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.

2) Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3) Identify fluid drain ports and clearance requirements for proper fluid drain.

4) Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

5) Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.

6) Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer, and, testing agency.

B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: With engine and generator mounted on rails, identify center of gravity and total weight, including full fuel tank, supplied enclosure, external silencer, subbase-mounted fuel tank, skid-mounted load bank, and each piece of equipment not integral to the engine generator, and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

5. Report of sound generation.

6. Report of exhaust emissions showing compliance with applicable regulations.

7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

D. Field quality-control reports.

E. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

b. Operating instructions laminated and mounted adjacent to generator location.

c. Training plan.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.

2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Engine generator housing, subbase fuel tank, engine generator, batteries, battery racks, silencers, [load banks, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels. Water shall be substituted for diesel fuel in fuel tank during test.

a. Component Importance Factor: 1.0.

B. B11 Compliance: Comply with B11.19.

C. NFPA Compliance:

1. Comply with NFPA 30.

2. Comply with NFPA 37.

3. Comply with NFPA 70.

4. Comply with NFPA 99.

5. Comply with NFPA 110 requirements for Level 2 EPSS.

D. UL Compliance: Comply with UL 2200.

E. Engine Exhaust Emissions: Comply with EPA Tier 2 requirements and applicable state and local government requirements.

F. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at [adjacent property boundaries with dwellings nearby due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

H. Level 2 sound enclosure

1. Ambient Temperature: 5 to 104 deg F (Minus 15 to plus 40 deg C).

2. Altitude: Sea level to 10m

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Power Rating: Standby.

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. EPSS Class: Engine generator shall be classified as a Class 72 according to NFPA 110.

F. Service Load: 630 kVA.

G. Power Factor: 0.8 lagging.

H. Frequency: 60 Hz.

I. Voltage: 480V ac.

J. Phase: Three-phase, four wire, wye

K. Induction Method: Turbocharged.

L. Governor: Adjustable isochronous, with speed sensing.

M. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

N. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor.

2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

O. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time:

a. Comply with NFPA 110, Type 10 system requirements.

b. 10 seconds.

P. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.

a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.

2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.

3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.

4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.

5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.

7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.

9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.

   a. Provide permanent magnet excitation for power source to voltage regulator.

10. Start Time:

    a. Comply with NFPA 110, Type 10 system requirements.

    b. 10seconds.

2.4 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.

E. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.

b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Muffler/Silencer:

1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

a. Minimum sound attenuation of 25 dB at 500 Hz.

b. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.

G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

H. Starting System: 12 or 24VDC electric, with negative ground.

1. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

2. Battery: Lead acid with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.

3. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

4. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.

5. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.

6. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

7. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F (minus 40 to plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.

   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.

   d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.

   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:

a. Steel Channel Support System: Reinforced steel box channel for generator support. Full height gussets at either end of channel and at generator mounting locations.

b. Fuel Level Gauge: Direct-reading, UL-listed, magnetic fuel level gauge with a hermetically sealed, vacuum-tested dial.

c. Low-Fuel Alarm Contact: Float-type switch for remote or local annunciation of a low-fuel-level condition.

d. Fill Tube: 2-inch (25-mm) NPT opening with lockable cap.

e. Leak detection in interstitial space.

f. 12 Foot venting with vented caps

g. Vandal-resistant fill cap.

h. Fill-pipe spill containment, minimum capacity 5 gal. (19 L).

i. Per the locations Fire Marshalls requirements for testing the tank integrity as well how the alarms will be tested.

j. Tank level indicator.

k. Fuel-Tank Capacity: 72 hour, minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.

l. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 PLATFORM

A. Aluminum platforms with railings on either side of generator enclosure for access to generator doors.

B. Generator supplier to engage platform manufacturer for the complete design of platform and railing system for generator.

C. Platform and railing dimensions:

1. To be confirmed based on final generator and fuel tank selection. Length of platforms (on either side) shall only be long enough to provide access around generator doors.

2. Railings to extend around platform(s). Platform shall not interfere with opening or access of generator enclosure doors.

3. Aluminum stair treads as required to achieve final height. Refer to the local building code for maximum riser height and tread length.

4. Final platform height shall not extend above 6’ of the highest device (circuit breaker, ESD, HMI).

D. Platforms shall be seismic certified.

E. Submit seismic and anchorage calculations and information for platform system.

2.7 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

a. Wall-Mounting Cabinet Construction: Rigid, self-supporting steel unit complying with NEMA ICS 6.

E. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.

2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.

3. Instruments: Located on the control and monitoring panel and viewable during operation.

a. Engine lubricating-oil pressure gage.

b. Engine-coolant temperature gage.

c. DC voltmeter (alternator battery charging).

d. Running-time meter.

e. AC voltmeter, [for each phase] [connected to a phase selector switch].

f. AC ammeter, [for each phase] [connected to a phase selector switch].

g. AC frequency meter.

h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

a. Cranking control equipment.

b. Run-Off-Auto switch.

c. Control switch not in automatic position alarm.

d. Overcrank alarm.

e. Overcrank shutdown device.

f. Low-water temperature alarm.

g. High engine temperature prealarm.

h. High engine temperature.

i. High engine temperature shutdown device.

j. Overspeed alarm.

k. Overspeed shutdown device.

l. Low fuel main tank.

(a) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required

m. Coolant low-level alarm.

n. Coolant low-level shutdown device.

o. Coolant high-temperature prealarm.

p. Coolant high-temperature alarm.

q. Coolant low-temperature alarm.

r. Coolant high-temperature shutdown device.

s. EPS load indicator.

t. Battery high-voltage alarm.

u. Low cranking voltage alarm.

v. Battery-charger malfunction alarm.

w. Battery low-voltage alarm.

x. Lamp test.

y. Contacts for local and remote common alarm.

z. Low-starting air pressure alarm.

aa. Low-starting hydraulic pressure alarm.

bb. Remote manual stop shutdown device.

cc. Air shutdown damper alarm when used.

dd. Air shutdown damper shutdown device when used.

ee. Generator overcurrent-protective-device not-closed alarm.

ff. Hours of operation.

gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

F. Engine Generator Metering: Comply with Section 260913 "Electrical Power Monitoring and Control”

G. Connection to Datalink:

a. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.

b. Provide connections for datalink transmission of indications to remote data terminals via Ethernet I/P**.** Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

H. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

I. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
11. Audible-alarm silencing switch.
12. Air shutdown damper when used.
13. Run-Off-Auto switch.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.
19. Generator overcurrent-protective-device not-closed alarm.

J. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

K. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case circuit breaker, thermal-magnetic type; 100 percent rated; complying with UL 489:

a. Tripping Characteristic: Designed specifically for generator protection.

b. Trip Rating: Matched to generator output rating.

c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.

d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2. Molded-case circuit breaker, electronic-trip type; 100 percent rated; complying with UL 489:

a. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.

b. Trip Settings: Selected to coordinate with generator thermal damage curve.

c. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.

d. Mounting: Adjacent to, or integrated with, control and monitoring panel.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.

2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.

1. Trip generator protective device on ground fault.

2.9 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12 lead alternator.

E. Range: Provide broad range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified[and as required by NFPA 110.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.

2. Maintain voltage within 20 percent on one step, full load.

3. Provide anti-hunt provision to stabilize voltage.

4. Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.10 LOAD BANK

A. Description:

B. Permanent, outdoor, weatherproof, remote-controlled, forced-air-cooled, resistive unit capable of providing a balanced three-phase, delta-connected load to engine generator at 50 percent rated-system capacity, at 80 percent power factor, lagging. Unit may contain separate resistive and reactive load banks controlled by a common control panel. Unit shall be capable of selective control of load in 25 percent steps and with minimum step changes of approximately 5 and 10 percent available.

1. Resistive Load Elements: Corrosion-resistant chromium alloy with ceramic and stainless-steel supports. Elements shall be double insulated and designed for repetitive on-off cycling. Elements shall be mounted in removable aluminized-steel heater cases. Galvanized steel is prohibited. Element's maximum resistance shall be between 100 and 105 percent of rated resistance.

2. Reactive Load Elements: Epoxy-encapsulated reactor coils.

3. Load-Bank Heat Dissipation: Integral fan with totally enclosed motor shall provide uniform cooling airflow through load elements. Airflow and coil operating current shall be such that, at maximum load, with ambient temperature at the upper end of specified range, load-bank elements operate at not more than 50 percent of maximum continuous temperature rating of resistance elements.

4. Load-Element Switching: Remote-controlled contactors switch groups of load elements. Contactor coils are rated 120 V. Contactors shall be located in a separate NEMA 250, Type 3R enclosure within load-bank enclosure, accessible from exterior through hinged doors with tumbler locks.

5. Contactor Enclosures: Heated by thermostatically controlled strip heaters to prevent condensation.

6. Load-Bank Enclosures: NEMA 250, Type 3R, aluminized steel complying with NEMA ICS 6. Louvers at cooling-air intake and discharge openings shall prevent entry of rain and snow. Openings for airflow shall be screened with 1/2-inch- (13-mm-) square, galvanized-steel mesh. Reactive load bank shall include automatic shutters at air intake and discharge. Components other than resistive elements shall receive exterior epoxy coating with compatible primer. Comply with requirements in Section 099600 "High-Performance Coatings."

7. Protective Devices: Power input circuits to load banks shall be fused, and fuses shall be selected to coordinate with generator circuit breaker. Fuse blocks shall be located in contactor enclosure. Cooling airflow and overtemperature sensors shall automatically shut down and lock out load bank until manually reset. Safety interlocks on access panels and doors shall disconnect load power, control, and heater circuits. Fan motor shall be separately protected by overload and short-circuit devices. Short-circuit devices shall be noninterchangeable fuses with 200,000-A interrupting capacity.

8. Control Sequence: Control panel may be preset for adjustable single-step loading of generator during automatic exercising.

2.11 OUTDOOR ENGINE GENERATOR ENCLOSURE

A. Description:

1. Vandal-resistant, sound-attenuating, weatherproof steel housing; wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

    a. Sound Attenuation Level: 2.

B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).

C. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Hinged Doors: With padlocking provisions.

E. Space Heater: Thermostatically controlled and sized to prevent condensation.

F. Lighting: Provide weather-resistant LED lighting with 50 fc (550 lx) average maintained.

G. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

H. Muffler Location: External to enclosure.

I. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.

2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

J. Interior Lights with Switch: Factory-wired, vapor-proof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.

2. DC lighting system for operation when remote source and generator are both unavailable.

K. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

2.12 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene or Natural rubber separated by steel shims.

2. Shore A Scale Durometer Rating: 50

3. Number of Layers: three

4. Minimum Deflection: 1 inch (25 mm)

2.13 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.14 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Test generator, exciter, and voltage regulator as a unit.

3. Full load run.

4. Maximum power.

5. Voltage regulation.

6. Transient and steady-state governing.

7. Single-step load pickup.

8. Safety shutdown.

9. Report factory test results within 10 days of completion of test.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

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

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions[and with NFPA 110.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."

2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."

E. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 FIELD QUALITY CONTROL

A. Testing Agency:

1. Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

2. Perform tests and inspections[with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

(a) Compare equipment nameplate data with Drawings and the Specifications.
(b) Inspect physical and mechanical condition.
(c) Inspect anchorage, alignment, and grounding.
(d) Verify that the unit is clean.

b. Electrical and Mechanical Tests:

(a) Perform insulation-resistance tests according to IEEE 43.
(b) Machines Larger Than 200 hp (150 kW): Test duration shall be 10 minutes. Calculate polarization index.
(c) Machines 200 hp (150 kW) or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
(d) Test protective relay devices.
(e) Verify phase rotation, phasing, and synchronized operation as required by the application.

(f) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
(g) Perform vibration test for each main bearing cap.
(h) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

   c. Verify acceptance of charge for each element of the battery after discharge.

   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

7. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

8. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (8 m) from edge of the generator enclosure and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.

2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION

SECTION 26 36 00 – TRANSFER SWITCHES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1. Contactor-type automatic transfer switches.
2. Molded-case-type automatic transfer switches.
3. Nonautomatic transfer switches.
4. Transfer switch accessories.

1.2 RELATED DOCUMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch**,** power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative and testing agency.

B. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Features and operating sequences, both automatic and manual.
b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.

a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA ICS 1.

C. Comply with NFPA 99.

D. Comply with NFPA 110.

E. Comply with UL 1008 unless requirements of these Specifications are stricter.

F. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
2. Short-time withstand capability for 30 cycles.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

K. Neutral Terminal: Solid and fully rated unless otherwise indicated.

L. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

M. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

N. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed, shrinkable sleeve markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

O. Enclosures: General-purpose NEMA 250, Type 12, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 MOLDED-CASE-TYPE AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using contactor-based components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Compression
7. Ground Lugs and Bus-Configured Terminators: Compression type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

C. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

a. Initiation occurs without active control of generator.
b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

D. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Transfer Switches Based on Molded-Case-Switch Components: Comply with UL 489 and UL 869A.

G. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98

percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:

    a. Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
    b. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is unavailable.

H. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and

emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 TRANSFER SWITCH ACCESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

    a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
    b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
    c. Transition:

        1) Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
        2) Provide closed-transition operation when transferring between power sources.

    d. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
    e. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
    f. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
    g. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.

h. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
i. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for standby systems. Include results of test for the following conditions:

a. Overvoltage.
b. Undervoltage.
c. Loss of supply voltage.
d. Reduction of supply voltage.
e. Alternative supply voltage or frequency is at minimum acceptable values.
f. Temperature rise.
g. Dielectric voltage-withstand; before and after short-circuit test.
h. Overload.
i. Contact opening.
j. Endurance.
k. Short circuit.
l. Short-time current capability.
m. Receptacle withstand capability.
n. Insulating base and supports damage.

PART 3 - - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."
3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

B. Identify components according to Section 260553 "Identification for Electrical Systems."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Route and brace conductors according to manufacturer's written instructions. and Section 260529 "Hangers and Supports for Electrical Systems."] Do not obscure manufacturer's markings and labels.

I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

1. Engage qualified testing agency to administer and perform tests and inspections.

2. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
3. Administer and perform tests and inspections[with assistance of factory-authorized service representative.

B. Tests and Inspections:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of all control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
    k. Perform visual and mechanical inspection of surge arresters.
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
        3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

    a. Perform insulation-resistance tests on all control wiring with respect to ground.
    b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
    c. Verify settings and operation of control devices.
    d. Calibrate and set all relays and timers.
    e. Verify phase rotation, phasing, and synchronized operation.
    f. Perform automatic transfer tests.
    g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION

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SECTION 26 43 00- SURGE PROTECTION DEVICES (SPD)

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).

B. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

C. The requirements of Section 26 00 00 – Electrical Work, General, apply to the WORK of this Section

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards:

1. ANSI/UL 1449, Fourth Edition, Safety Surge Protective Devices

2. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits

3. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connect to Low-Voltage (1000V and Less) AC Power Circuits

4. UL 1283, Safety Electromagnetic Interference Filters

5. NFPA 70, National Electric Code

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 26 00 00– Electrical Work, General.

B. Shop Drawings:

1. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.

C. Product Data:

1. Manufacturer’s technical information, including catalog information.

2. Manufacturer's technical specifications with assembly and component ratings.

D. Certifications: Certification that SPD devices comply with standards referenced in this Section.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have at least five (5) years' experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least five (5) years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.

2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.

3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.

B. SPD shall be suitable for operation under the following environmental conditions:

1. Relative Humidity: Zero to 95%, non-condensing

2. Frequency: 47 to 63 Hz

3. Temperature: Zero to 149°F

4. SPD operating voltage shall be suitable for the associated SPD location(s).

5. SPD shall be suitable for internal and external mounting. SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:

a. Section 26 00 00 – Electrical Work, General

b. Section 26 11 10 – Low Voltage Switchgear

c. Section 26 12 16– Panelboards and General Purpose Dry Type Transformers

d. Section 26 29 00– Low Voltage Motor Control Centers

C. SPD shall include a surge suppression path for each mode as required for the system configuration. Each mode shall be individually fused and equipped with thermal cutouts. SPD short-circuit current rating shall be 200 kA. Protection modes shall include, to the extent applicable, the following:

1. Line-to-line

2. Line-to-neutral

3. Line-to-ground

4. Neutral-to-ground

D. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

E. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115% of nominal system operating voltage.

F. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	**208Y/120**	**480Y/277**
L-N,L-G, N-G	800	1200
L-L	1200	2000

G. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following:

Category	**Application**	**Per Phase**	**Per Mode**
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

H. Provide SPD equipped with the following accessories:

1. Surge counter with display for indicating the number of surges detected.

2. LED indicators for monitoring device status.

3. Audible alarm and silence switch for indicating an inoperative condition.

4. Dry contacts, “form C”, for remote annunciation of unit status.

I. Source Quality Control: Perform manufacturer’s standard factory tests on equipment. Tests shall be in accordance with ANSI/UL 1449.

J. Manufacturers: General Electric, Eaton, Schneider Electric/Square D Company, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Install SPD in accordance with equipment manufacturer’s written recommendations and instructions and the Contract Documents.

B. Where an SPD cannot be installed integral with the equipment to which it is connected, conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION

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SECTION 26 50 00 - LIGHTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide luminaires and accessories, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes

NFPA 70	National Electric Code
NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
International Building Code (IBC)	Earthquake Requirements
UL-924	Standard for Safety Emergency Lighting and Power Equipment

Standards of the Certified Ballast Manufacturer's Association

B. Specifications

1. 26 09 23 - Lighting Control Devices
2. 26 27 26 – Wiring Devices
3. 26 52 13 Emergency and Exit Lighting
4. 26 56 13 Lighting Poles and Standards

1.3 CONTRACTOR SUBMITTALS

A. Furnish the following product information in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Furnish the following information:

1. Exterior Luminaires
   a. catalog data sheets and photos
   b. luminaire finish and metal gauge
   c. lens material, pattern, and thickness
   d. IES lighting classification and isolux diagram
   e. fastening details to wall or pole
   f. for light poles: wind loading; complete dimensions; and finish
2. Lamps

a. voltages
b. colors
c. approximate life (in hours)
d. approximate initial lumens
e. lumen maintenance curve
f. lamp type and base

3. Photocells
   a. voltage and power consumption
   b. capacity
   c. contacts and time delay
   d. operating levels
   e. enclosure type and dimensions
   f. temperature range

PART 2 -- PRODUCTS

2.1 LUMINAIRES

A. General

1. Additional WORK requirements are indicated in the Luminaire Schedule on the Drawings.

2. All luminaires shall utilize light emitting diode (LED) lamps.

3. All LED drivers shall be temperature rated for the project location or 40degC (104degF) whichever is higher.

B. Provide a feed-through type or separate junction box.

C. Provide minimum 18 AWG wire leads.

D. Provide components that are accessible and replaceable without removing the luminaire from the ceiling.

E. Exterior Installations

1. Installations shall be UL-labeled as "Suitable for Wet Locations."

2. When factory-installed photocells are provided, the entire assembly shall be UL-labeled.

2.2 LIGHTING CONTROL

A. Switch

1. Each exterior light fixture shall be controlled by an individual light switch in addition to its photocell.

2. Locate switches where shown on the Contract Drawings or as directed by the ENGINEER.

B. Photocell

1. Photo Control: automatic ON-OFF switch

2. Housing where not built into the fixture: self-contained; die-cast aluminum; unaffected by moisture, vibration, or temperature changes

3. Settings: ON at dusk; OFF at dawn

4. Provide a time delay feature in order to prevent false switching.

5. Field-adjustable to control operating levels

6. Manufacturer, or Equal

a. Tork

b. Paragon

2.3 POLES

A. Rating (with luminaire): 100-mph steady winds without incurred damage

B. Material: steel or extruded aluminum

C. Hinged by use of a stainless steel hinge pin

PART 3 -- EXECUTION

3.1 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.

2. Provide necessary hangers, pendants, canopies, and other accessories.

3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to the building and to concrete pole bases as required to safely mount the luminaire.

4. Install the luminaire plumb and level.

5. The mounting heights indicated for wall-mounted or pendant-mounted luminaires are from the bottom of the luminaire to finished floor or finished grade, whichever is applicable.

6. Install each luminaire outlet box with a galvanized stud.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.

2. Space single-stem hangers on continuous-row luminaires 48-inches apart or as recommended by the manufacturer.

3. Provide twin-stem hangers on single luminaires.

C. Pole Mounting

1. Provide a cast-in-place concrete base.

2. Install the pole base flush with the finished grade where located in areas not subject to vehicular traffic, and 30 inches above the finished grade when the pole is located in areas subject to damage from vehicular traffic.

3. Set the luminaire poles on anchor bolts and secure with double nuts on each bolt.

4. After the luminaire has been leveled and plumbed, dry-pack the luminaire base with grout.

3.2 LAMPS

A. Within each luminaire, provide the number and type for which the luminaire is designed, unless otherwise indicated.

3.3 LIGHTING CONTROL

A. Outdoor Luminaires

1. The photocells shall switch lights ON at dusk and OFF at dawn.

B. Dimming Systems

1. Install in accordance with the manufacturer's recommendations.

3.4 CLEAN-UP

A. Remove labels and other markings, except the UL listing mark.

B. Wipe the luminaires inside and out to remove construction dust.

C. Clean the luminaire plastic lenses with an antistatic cleaner only.

D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.

E. Replace defective lamps at the Date of Substantial Completion.

END OF SECTION

SECTION 26 52 13 - EMERGENCY AND EXIT LIGHTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

1.2 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with integral or remote emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support, arranged by designation.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, coordinated with each other, using input from installers of the items involved:

B. Product Certificates: For each type of luminaire.

C. Seismic Qualification Data: Certificates, for luminaires, accessories, and components, from manufacturer.

D. Sample Warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion.

B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

PART 2 -- GENERAL

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the basis of design products as scheduled on Drawings.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

D. Comply with NFPA 70 and IBC.

E. Comply with NEMA LE 4 for recessed luminaires.

F. Comply with UL 1598 for recessed luminaires.

G. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

1. Emergency Connection: Operate LED driver continuously upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast or LED driver as applicable.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal

voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: 0 deg F (minus 18 deg C) to 104 deg F (40 deg C) minimum range, with an average value exceeding 95 deg F (35 deg C) over a 24-hour period.
    b. Ambient Storage Temperature: Not less than minus 4 deg F (minus 20 deg C) and not exceeding 140 deg F (60 deg C).

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Test Push-Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

H. External Type: Self-contained, modular, battery-inverter unit remote mounted from luminaire, suitable for powering one or more luminaires or lamps.

1. Emergency Connection: Operate luminaire(s) continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
2. Operation: Relay automatically turns lamp(s) or luminaire(s) on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Automatically disconnect luminaire(s) from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects luminaire(s) from battery, and battery is automatically recharged and floated on charger.
3. Nightlight Connection: Operate remote fixture continuously.
4. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EXIT SIGNS

A. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.

2.3 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.

2. Designed to permit re-lamping without use of tools.

3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position.

C. Diffusers and Globes:

1. Glass: Annealed crystal glass unless otherwise indicated.

2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

3. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.

D. METAL FINISHES

1. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and metallic channel and angle supports.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:

1. Sized and rated for luminaire and emergency power unit weight.

2. Able to maintain luminaire position when testing emergency power unit.

3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of fixture weight.

D. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

2. Do not attach fixtures directly to gypsum board.

E. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports, signed and dated by individual responsible for performing tests and inspections.

END OF SECTION

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SECTION 26 56 13 - LIGHTING POLES AND STANDARDS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Section Includes:

1. Poles and accessories for support of luminaires.

1.1 DEFINITIONS

A. EPA: Equivalent projected area.

B. Luminaire: Complete lighting fixture.

C. Pole: Luminaire-supporting structure, including tower used for large-area illumination.

D. Standard: See "Pole."

1.2 ACTION SUBMITTALS

A. Product Data: For each pole, accessory, and luminaire-supporting device.

1.3 INFORMATIONAL SUBMITTALS

A. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements according to AASHTO LTS-6-M and that load imposed by luminaire and attachments has been included in design.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data for pole-mounted accessories.

1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of pole(s) that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within a specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs from special warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 -- PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

B. Retain this article if manufacturer is responsible for selecting poles and other luminaire-supporting components and certifying them to suit wind, ice, and other load conditions as expressed in AASHTO LTS-6-M.

C. Structural Characteristics: Comply with AASHTO LTS-6-M.

D. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

2.2 STEEL POLES

A. Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the basis of design products as scheduled on Drawings.

B. Retain one of two "Source Limitations" paragraphs below.

C. Source Limitations: Obtain poles from single manufacturer or producer.

D. Source Limitations: For poles, obtain each color, grade, finish, type, and variety of pole from single source with resources to provide products of consistent quality in appearance and physical properties.

E. Retain one of two "Poles" paragraphs below and coordinate with Drawings.

F. Poles: Comply with ASTM A 500/A 500M, Grade B carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Round, tapered.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

G. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adaptor fitting welded to pole, allowing the bracket to be bolted to the pole-mounted adapter, then bolted together with stainless-steel bolts.

H. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

I. Fasteners: Stainless steel, size and type as determined by manufacturer. Corrosion-resistant items compatible with support components.

1. Materials: Compatible with poles and standards as well as the substrates to which poles and standards are fastened and shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

J. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size indicated, and accessible through handhole.

K. Handhole: Oval shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

L. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported load multiplied by a 5.0 safety factor.

M. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.

3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high gloss, high-build polyurethane enamel.

N. Powder-Coat Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces according to SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair powder coat bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, according to SSPC-SP 5/NACE No. 1 or SSPC-SP 8.

2. Powder Coat: Comply with AAMA 2604.

a. Electrostatic-applied powder coating; single application and cured to a minimum 2.5- to 3.5-mils dry film thickness. Coat interior and exterior of pole for equal corrosion protection.

2.3 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, finished same as pole, and arranged to cover pole's mounting bolts and nuts.

2.4 MOUNTING HARDWARE

A. Anchor Bolts: Manufactured to ASTM F 1554, Grade 55, with a minimum yield strength of 55,000 psi (380,000 kPa).

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.

2. Bent rods size and length as recommended by pole manufacturer.

B. Nuts: ASTM A 563, Grade A, Heavy-Hex

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.

C. Washers: ASTM F 436, Type 1.

1. Galvanizing: Hot dip galvanized according to ASTM A 153, Class C.

2.5 GENERAL FINISH REQUIREMENTS

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Noticeable variations in same piece are unacceptable.

PART 3 -- EXECUTION

3.1 POLE FOUNDATION

A. Driven steel pile with welded baseplate drilled to match pole baseplate.

3.2 POLE INSTALLATION

A. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level according to pole manufacturer's written instructions.

C. Raise and set pole using web fabric slings (not chain or cable) at locations indicated by manufacturer.

3.3 CORROSION PREVENTION

A. Steel Conduits: Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

3.4 GROUNDING

A. Ground Metal Poles and Support Structures: Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

END OF SECTION

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SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 -- GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 -- PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

C. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Busbar Connectors: Cast silicon bronze, solderless exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch (100-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm)in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm) clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch (483- or 584-mm) equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches (1827 or 914 mm) long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 IDENTIFICATION

A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches (900 mm).

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

4. Install grounding and bonding conductors in 3/4-inch (21-mm) PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 12 inches (300 mm) above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot (1 sq. mm/linear meter) of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted, vertically mounted rack grounding busbar unless the enclosure and rack are

manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

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SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 --GENERAL

1.1 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Uninterruptible power supplies, rack-mount.
5. Grounding.

B. Related Requirements:

1. Section 27 13 00 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

2. Section 27 15 00 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For equipment frames from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on

the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

PART 2 --PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

2.2 BACKBOARDS

A. Backboards: ACX plywood sheets, coated with fire-resistant paint or fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Section 06 10 00 "Rough Carpentry."

2.3 EQUIPMENT FRAMES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. B-line, an Eaton business.
2. Chatsworth.
3. Ortronics, Inc.
4. Siemon Co. (The).

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch (480-mm) panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, steel or aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding bus bar, and a power strip.
2. Racks shall be 4-post, free-standing fames, 29-inches deep by 84-inches high.
3. Baked-polyester powder coat finish for steel, powder coat or natural for aluminum.

D. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Provide single-sided vertical cable management with covers at front and rear of 4-post rack.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.
5. Provide horizontal cable management panels above, below, and between each patch panel, with a minimum height of one rack unit each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Manufacturer: Leviton P1000 series or equal.
2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Rack mounting.
4. Minimum of 12, 120-V ac, NEMA WD 6, 5-20R receptacles.
5. 20A rated with resettable circuit-breaker overload protection.
6. Cord connected to rack-mount UPS with 6-foot (1.8m) line cord with locking or non-locking plug.
7. LED indicator lights for power and protection status.
8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.

2.5 UNINTERRUPTABLE POWER SUPPLY

A. Uninterruptable Power Supply: Comply with UL 1778.

1. Manufacturer: Eaton model EX or equal.
2. 1.5, 2.2, and 3.0 KVA capacities as indicated on Drawings.
3. 120-V input/output.
4. Cord connected to wall receptacle with 6-foot (1.8m) line cord with locking plug with rating as required by UPS capacity.

    a. Use L5-30P plug for 3.0kVA UPS on 30A branch circuit supply.
    b. Use L5-20P plug for 2.2kVA UPS on 20A branch circuit supply.
    c. Use L5-15P plug for 1.5kVA UPS on 15A branch circuit supply.

5. Online, double-conversion with sine wave out.
6. Integral surge suppression and noise filtering.
7. USB and serial communications interface.
8. Designed for rack mounting.

9. Hot-swappable batteries providing 18-minute minimum run time.

2.6 GROUNDING

A. Comply with requirements in Section 26 05 26 "Grounding and Bonding" for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4-inch thick by 4 inches wide by 12 inches long (6-mm thick by 100 mm wide by 300 mm long) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with J-STD-607-A.

2.7 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 --EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 26 05 33 "Raceways and Boxes" for materials and installation requirements for telecommunications entrance pathways.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Coordinate layout and installation of communications equipment with Owner's personnel and telecommunications service providers. Coordinate service entrance arrangement with local exchange carrier.

1. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
2. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications,

electronic safety and security, and related systems that share space in the equipment room.

E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

F. Plywood backboards shall extend from floor to 96 inches above floor, and installed over entire width of walls identified on Drawings, unless otherwise indicated.

3.3 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical."

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION

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SECTION 27 11 16 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 19-inch equipment racks.
2. 19-inch freestanding and wall-mounted equipment cabinets.
3. Power strips.
4. Grounding.
5. Labeling.

1.2 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications racks, frames, and enclosures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer qualified layout technician, installation supervisor, and field inspector.

B. Seismic Qualification Data: Certificates, from manufacturer.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

B. UL listed.

C. RoHS compliant.

D. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 19-INCH EQUIPMENT RACKS

A. Description: Two post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch (482.6-mm) equipment mounting with an opening of 17.72-inches (450-mm) between rails.

B. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded aluminum**.**
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black

C. Floor-Mounted Racks:

1. Overall Height: 72 inches (1828.8 mm) 84 inches (2133.6 mm).
2. Overall Depth: 23 inches (584.2 mm) 29 inches (736.6 mm).
3. Upright Depth: 3 inches (76.2 mm) 6 inches (152.4 mm).
4. Two-Post Load Rating: 200 lb (91 kg) 400 lb (181 kg).
5. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug**,** and a power strip.
6. Base shall have a minimum of four mounting holes for permanent attachment to floor.
7. Top shall have provisions for attaching to cable tray or ceiling.

8. Self-leveling.

D. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.3 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting, with integral flanges.
3. Height: 1 RU.
4. Housing: Metal.
5. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
6. Front-facing receptacles.
7. LED indicator lights for power and protection status.
8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
11. Close-coupled, direct plug-in line cord.
12. Rocker-type on-off switch, illuminated when in on position.
13. Surge Protection: UL 1449, Type 3.

a. Maximum Surge Current, Line to Neutral: 72 kA.
b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and 500 V for neutral to ground.

2.4 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch (482.6- or 584.2-mm) equipment racks. Include a copper splice bar for transitioning to an

adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

3. Rack-Mounted Vertical TGB: 72 or 36 inches (1828.8 or 914.4 mm) long, with stainless-steel or copper-plated hardware for attachment to rack.

2.5 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches (50 mm) of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack TGB to near TGB or the TMGB.

1. Bond the shield of shielded cable to patch panel, and bond patch panel to TGB or TMGB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration**,** including optional identification requirements of this standard].

D. Labels shall be machine printed. Type shall be 1/8 inch (3 mm) 3/16 inch (5 mm) 1/4 inch (6 mm) in height.

END OF SECTION

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SECTION 27 13 13 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Category 6a twisted pair cable.
3. Twisted pair cable hardware, including plugs, jacks, patch panels, and cross-connects.
4. Grounding provisions for twisted pair cable.
5. Cabling identification products.
6. Source quality control requirements for twisted pair cable.

B. Related Requirements:

1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for data cabling associated with system panels and devices.

1.2 COPPER BACKBONE CABLING DESCRIPTION

A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration Drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system
e. Cross-connects.

f. Patch panels.
g. Patch cords.

4. Cross-Connects and Patch Panels: Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Twisted pair cable testing plan.

D. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. Product Certificates: For each type of product.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development] by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685 or Type CMP in listed plenum communications raceway
2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
3. Communications, Riser Rated: Type CMR complying with UL 1666 and ICEA S-103-701.
4. Communications, Riser Rated: Type CMP or Type CMR in listed plenum or riser communications raceway.
5. Communications, Riser Rated: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: 100-ohm, 23 AWG, four unshielded twisted pairs (UTP) plenum-rated cable, with internal spline, covered with a blue thermoplastic jacket.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

2.4 CATEGORY 6a TWISTED PAIR CABLE

A. Description: 100-ohm, 23 AWG, four unshielded twisted pairs (UTP) plenum-rated, with internal spline, covered with blue thermoplastic jacket.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

2.5 TWISTED PAIR CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware:

1. Twisted pair cable hardware shall meet the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.
4. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

B. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

D. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.
d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

E. Plugs and Plug Assemblies:

1. Male; eight position (8P8C); color coded modular telecommunications connector designed for termination of a single four-pair 100 ohm unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

G. Patch Cords: Factory-made, four-pair cables in **36-inch (900-mm) 48-inch (1200-mm)** lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

H. Faceplates:

1. Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Eight port, vertical double gang faceplates designed to mount to double gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work-area cords.

a. Flush-mount jacks, positioning the cord at a 45-degree angle.

I. Legend:

1. Factory labeled by silk-screening or engraving for stainless steel faceplates.
2. Machine printed, in the field, using adhesive-tape label.
3. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 SOURCE QUALITY CONTROL

A. Factory test cables on reels according to TIA-568-C.1.

B. Factory test cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install cables parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF PATHWAYS

A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."

B. Comply with Section 270529 "Hangers and Supports for Communications Systems."

C. Comply with Section 270536 "Cable Trays for Communications Systems."

D. Drawings indicate general arrangement of pathways and fittings.

3.4 INSTALLATION OF COPPER BACKBONE CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Manual," Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI's "Information Transport Systems Installation Manual," Ch. 6, "Cable Termination Practices." Use lacing bars and distribution spools.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI's "Information Transport Systems Installation Manual," Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.6 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

1. Administration Class: **2**
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
    b. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

C. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

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

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections

E. Retain "Tests and Inspections" Paragraph below to describe tests and inspections to be performed.

F. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

G. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

H. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

I. End-to-end cabling will be considered defective if it does not pass tests and inspections.

J. Prepare test and inspection reports.

END OF SECTION

SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable connecting hardware, patch panels, and cross-connects.
8. Cabling identification products.

1.2 OPTICAL FIBER BACKBONE CABLING DESCRIPTION

A. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

a. Telecommunications rooms plans and elevations.
b. Telecommunications pathways.
c. Telecommunications system access points.
d. Telecommunications grounding system
e. Cross-connects.

f. Patch panels.
g. Patch cords.

5. Cross-connects and patch panels.

C. Optical fiber cable testing plan.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For RCDD installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

D. Product Certificates: For each type of product.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and, Cabling Administration Drawings, and field testing program development by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD a Technician.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

1.7 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

D. Grounding: Comply with TIA-607-B.

2.2 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, 8-fiber, nonconductive tight buffer, optical fiber cable.

B. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAA for detailed specifications.

C. Conductive cable shall be aluminum armored type.

D. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

E. Minimum Overfilled Modal Bandwidth-length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

F. Jacket:

1. Jacket Color: Orange
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit.

4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP, or Type OFNR in metallic conduit.
5. Riser Rated, Nonconductive: Type OFNP, complying with UL 1666.
6. Riser Rated, Nonconductive: Type OFNP or Type OFNR in listed riser or plenum communications raceway.
7. Riser Rated, Nonconductive: Type OFNP or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
8. Plenum Rated, Conductive: Type OFCP complying with NFPA 262.
9. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
10. Plenum Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
11. Riser Rated, Conductive: Type OFCP; complying with UL 1666 and ICEA S-103-701.
12. Riser Rated, Conductive: Type OFCP, Type OFNP, or Type OFCR or Type OFNP in listed riser or plenum communications raceway.
13. Riser Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit.

2.3 50/125 MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM2)

A. Description: Multimode, 50/125-micrometer, 8-fiber, nonconductive, tight buffer, optical fiber cable.

B. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.

C. Conductive cable shall be aluminum armored type.

D. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

E. Minimum Overfilled Modal Bandwidth-length Product: 500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

F. Jacket:

1. Jacket Color: Orange.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.

2. Plenum Rated, Nonconductive: Type OFNP in listed plenum communications raceway.
3. Plenum Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit.
4. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP, or Type OFNR in metallic conduit.
5. Riser Rated, Nonconductive: Type OFNP, complying with UL 1666.
6. Riser Rated, Nonconductive: Type OFNP or Type OFNR in listed riser or plenum communications raceway.
7. Riser Rated, Nonconductive: Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
8. Plenum Rated, Conductive: Type OFNP, complying with NFPA 262.
9. Plenum Rated, Conductive: Type OFCP or Type OFNP in listed plenum communications raceway.
10. Plenum Rated, Conductive: Type OFC, Type OFN, Type OFCG, Type OFNG, Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
11. Riser Rated, Conductive: Type OFCP; complying with UL 1666 ICEA S-103-701.
12. Riser Rated, Conductive: Type OFCP, Type OFNP, or Type OFCR or Type OFNP in listed riser or plenum communications raceway.
13. Riser Rated, Conductive: Type OFCP, Type OFNP, Type OFCR, or Type OFNR in metallic conduit.

2.4 OPTICAL FIBER CABLE HARDWARE

A. Standards:

1. Comply with Optical Fiber Connector Intermateability Standard specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: **One** for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths.

D. Connector Type: Type SC complying with TIA-604-3-B**,** connectors.

E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than **0**.25 dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

C. Factory test pre-terminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. In the communications equipment room, provide a 10-foot- (3-m-) long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.5 GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

1. Administration Class: Class 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration including optional identification requirements of this standard.

C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.

D. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal

hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

F. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections[with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes fire alarm systems.

B. Related Requirements:

1.2 DEFINITIONS

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NICET: National Institute for Certification in Engineering Technologies.

D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.3 SYSTEM DESCRIPTION

A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.

1.4 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.

B. Fire alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.

C. Fire alarm signal shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving locations and Fireworks system.
5. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
6. Close fire and smoke dampers in air ducts of system serving zone where alarm was initiated.
7. Transmit an alarm signal to the access control system to unlock required doors.
8. Record events in the system memory.

D. Supervisory signal initiation shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper.

E. System trouble signal initiation shall be by one or more of the following devices or actions:

1. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
2. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
3. Loss of communications with any addressable system device, remote annunciator, Ethernet module, or networked panel.
4. Loss of primary power at the FACP.
5. Ground or a single break in FACP internal circuits.
6. Abnormal ac voltage at the FACP.
7. A break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at the FACP.

F. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event in system memory and transmit signal to Fireworks system.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire alarm system design.
b. Fire alarm certified by NICET, minimum Level III, with Class I-C permit issued by the State.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
3. Device Address List: Coordinate with final system programming.
4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
6. Batteries: Size calculations.
7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
8. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A,

recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

E. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

F. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and authorities having jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.

    a. Hard copies on paper to Owner, Architect, and authorities having jurisdiction.
    b. Electronic media may be provided to Architect.

1.6 QUALITY ASSURANCE

A. Vendor Qualifications: Manufacturer’s authorized representative with office located within Alaska, staffed with Alaska-based factory technicians fully capable of supervising installation, system startup and checkout, and providing emergency service.

B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Owner's written permission.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.

2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than 1 unit.
3. Smoke, Fire, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamper proofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. FACP and Equipment:

a. Edwards Systems Technology Inc., EST3 Panel or equal.

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864 listed.
2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment and elevator monitoring and control.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Circuits:

1. Signaling Line Circuits: NFPA 72, Class A, Style 6.
2. Notification-Appliance Circuits: NFPA 72, Class A, Style Z.
3. System Layout: Maintain 25 percent spare capacity on each signaling line and notification-appliance circuit.
4. Actuation of alarm notification appliances, annunciation, shall occur within 10 seconds after the activation of an initiating device.

5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41.

E. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

F. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

G. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

H. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

I. Transmission to Remote Alarm Receiving Locations: Automatically transmit alarm, supervisory, and trouble signals to a remote location through a voice dialer and telephone lines, and to the Fireworks system at the School District Office via a network module and WAN connection.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signal, supervisory signal, and alarm transmitter shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
2. Power supply shall have dedicated circuit breaker(s) for this connection. Label the circuit breaker(s) red and identify it with "FIRE ALARM SYSTEM POWER."

K. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Batteries: Sealed lead calcium.

2. Battery and Charger Capacity: Comply with NFPA 72.

L. Surge Protection:

1. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE ALARM BOXES

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.
2. Station Reset: Key- or wrench-operated switch.
3. Protective Wire Guard: Factory-fabricated wire guard with red polyester epoxy or nickel-plated finish, hinged at the top to permit lifting for access to initiate an alarm. Provide wire guards on manual stations in the gymnasium and shop.

2.4 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:

a. Sensor: LED or infrared light source with matching silicon-cell receiver.

b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

   a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.

5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where indicated.
7. Each sensor shall have multiple levels of detection sensitivity.
8. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
9. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.
10. Remote Test Station: Key switch and LED indicator for remote testing and annunciation of duct mounted smoke detector.

2.5 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate-of-rise of temperature that exceeds 15 deg F (8 deg C) per minute, unless otherwise indicated.

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F (88 deg C).

1. Mounting: Plug-in base, interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on a faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens, or faceplate.

1. Rated Light Output: 15/75 candela, unless otherwise indicated.
2. Strobe Leads: Factory connected to screw terminals.
3. Faceplates shall be white for interior devices and red for exterior devices.

2.7 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to control equipment.

2.8 GUARDS FOR PHYSICAL PROTECTION

A. Description: Welded wire mesh of size and shape for smoke detector, notification devices, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of the device.
2. Finish: Paint of color to match the protected device.
3. Provide guards for all devices in gymnasium.

2.9 WIRE AND CABLE

A. Comply with requirements in Section 28 05 13 “Conductors and Cables for Electronic Safety and Security”.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Smoke or Heat Detector Spacing:

1. Smooth ceiling spacing shall not exceed 30 feet (9 m).
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.

B. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.

C. Duct Smoke Detectors: Comply with NFPA 72 and IMC. Install sampling tubes so they extend the full width of the duct. Install remote test-indicator station where duct detector is elevated or otherwise readily accessible, or where indicated on drawings.

D. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

E. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling.

F. Device Location-Indicating Lights: Locate in public space near the device they monitor.

G. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

H. Annunciator: Install with top of panel not more than 66 inches (1680 mm) above the finished floor.

3.2 WIRING INSTALLATION

A. Install wiring according to the following:

1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Section 26 05 33 Raceways and Boxes for Electrical Systems."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices.

1. Paint fire alarm system junction box covers red.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Section 26 05 53 "Identification for Electrical Systems."

B. Install instructions frame in a location visible from the FACP.

C. Label power-supply circuit breaker(s) "FIRE ALARM."

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.

    a. Detectors that are outside their marked sensitivity range shall be replaced.

5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide for one visit to Project outside normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices.

END OF SECTION

SECTION 31 10 00 - SITE PREPARATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. In its initial move onto the Site, the CONTRACTOR shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to construction activities, boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents.

1.2 SITE INSPECTION

A. Prior to moving onto the Site, the CONTRACTOR shall inspect the Site conditions and review maps of the Site and facilities delineating the OWNER's property and right-of-way lines.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 SITE ACCESS

A. The CONTRACTOR shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.

B. **Utility Interference:** Where existing utilities interfere with the WORK, notify the utility owner and the ENGINEER before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

A. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the WORK, create a hazard to safety, or impair the subsequent usefulness of the WORK, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.

B. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

C. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the OWNER’s approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the CONTRACTOR's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the WORK.

END OF SECTION

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SECTION 31 13 00 – TREE PROTECTION AND TRIMMING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Scope of Work: The work includes labor, equipment, and materials necessary for existing tree relocation, protection and trimming.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Standards: Code of Standards of the American Association of Nurserymen and the American Standard for Nursery Stock and National Arbor Association Standards for Pruning and Guying of Shade Trees.

B. Arrange a preconstruction meeting to review schedule and specification.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals

B. Schedule and Work Plan: Submit detailed schedule and work plan for each part of the work.

C. Chain Link Protection Fencing: Submit proposed methods and sequence of site preparation to the ENGINEER for review prior to start of work.

1.4 PROJECT CONDITIONS

A. Carefully examine the site before submitting a bid. Be informed of the site conditions including adjacent properties, utilities, and soil conditions.

B. Should the Contractor find any discrepancies between Drawings and physical conditions, inform the ENGINEER immediately for clarification.

1.5 PROTECTION

A. Use every precaution to prevent damage to and provide protection as necessary of existing plant material. Repair or replace to original condition, as acceptable to the ENGINEER and at no additional cost to the OWNER, any material or work damaged or destroyed while performing work.

B. Vegetation protection fencing shown on drawings are minimum required for work. The CONTRACTOR shall be responsible for providing additional temporary fencing during the work as necessary to protect vegetation.

PART 2 -- PRODUCTS

2.1 CHAIN LINK FENCE FOR TREE PROTECTION

A. Frame: ASTM A 120, schedule 40 steel pipe, standard weight, one piece without joints.

B. Fabric Two-inch diamond mesh steel wire, interwoven, 11-gauge, top selvage twisted tight, bottom selvage knuckle end closed. RS RR-F-191, type 1, zinc-coated steel.

C. Line Posts: 1.9-inch diameter steel pipe.

D. Comer and Terminal Posts: 2.88-inch steel pipe.

E. Fittings: Sleeves, bonds, clips, rail ends, tension bars, fasteners and fittings; steel.

F. Tension Wire: 6-gauge thick steel, single strand.

G. Top Rail and Post Braces: 1–5-inch o.d. schedule 40 galvanized pipe.

PART 3 -- EXECUTION

3.1 PREPARATION

A. Flagging of Existing Trees: Flag trees to remain and to be removed with a bright colored ribbon. Notify the ENGINEER at least 48 hours prior to commencing of work to verify all trees that are flagged.

B. Do not park any vehicles or equipment, nor store any materials or stockpiled soil, nor dispose of building materials, chemicals, petroleum products or other detrimental substances within drip line of tree. Protect trees from flame, smoke and heat. Construction access to site shall not occur beneath drip line of trees.

3.2 EXISTING TREES TO REMAIN

A. General:

1. Protect root systems from smothering. Restrict foot traffic to prevent excessive compaction of soil over root systems.

2. Individual trees and areas shown to remain shall be protected by six (6) foot high chain link fence. Install fencing before site preparation, grading and clearing and grubbing operations.

3. Under no circumstances shall the Contractor remove existing trees designated to remain for his/her convenience or ease of construction.

4. Prior to installation, stake the location of protection fencing for approval by the ENGINEER. Location stakes or marking shall be placed not greater than ten (10) feet on-center.

B. Excavate within drip line of trees only where shown:

1. Where trenching for utilities is required within drip line, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots. The CONTRACTOR shall notify the ENGINEER prior to cutting roots over 6-inch diameter. Roots up to and including 3/4-inch shall be cut by hand saws. Do not leave roots exposed to sun or drying for more than 24 hours. Protect all exposed roots with moist organic mulch or burlap and backfill as soon as possible.

2. Where excavating for new construction is required within drip line of tree, excavate by hand to minimize damage to roots and perform as follows:

a. Use narrow tine spading forks and comb soil to expose roots.

b. If main lateral roots are immediately adjacent to location of new construction cut roots three (3) inches from new construction.

c. Do not allow exposed roots to dry out before permanent backfill is placed.

d. Provide temporary earth cover, or pack with peat moss and wrap with burlap.

e. Water and maintain in moist condition until covered with backfill.

C. Guarantee:

1. Trees which are protected within fencing that become damaged or die shall be replaced with trees of the same species and equal size.

2. Damaged and destroyed trees which cannot be replaced shall be paid for at the rate of $50.00 per square inch of cross-sectional area measured three (3) feet above existing grade for trees up to and including six (6) inch caliper, and at the rate of $100.00 per square inch of cross sectional areas measured three (3) feet above existing grade for trees greater than six (6) inches caliper. This amount shall be credited to the OWNER.

3. These damaged and destroyed trees shall be removed from the site, the stumps grubbed and the ground surface repaired with all costs borne by the CONTRACTOR.

3.3 TRIMMING OF EXISTING TREES

A. General: Engage a qualified tree surgeon to remove branches from tree. No pruning unless approved and directed by the ENGINEER.

B. Pruning: Cut branches with sharp pruning instruments and do not break or chop. Prune flush with trunk surface.

C. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. All cuts over 1-1/2 inches in diameter shall be coated with an asphaltic emulsion material.

END OF SECTION

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SECTION 31 23 19 - DEWATERING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall dewater trench and structure excavations, in accordance with the Contract Documents. The CONTRACTOR shall secure all necessary permits to complete the requirements of this Section of the Specifications.

B. The CONTRACTOR shall evaluate and determine actual groundwater conditions and suitable dewatering systems to be utilized as part of the work.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Dewatering Plan

1. Prior to commencement of excavation, the CONTRACTOR shall submit a detailed plan and operation schedule for dewatering of excavations. The CONTRACTOR may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The CONTRACTOR's dewatering plan is subject to review by the ENGINEER.

1.3 QUALITY CONTROL

A. It shall be the sole responsibility of the CONTRACTOR to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the CONTRACTOR.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Standby pumping equipment shall be maintained on the Site.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The CONTRACTOR shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise in accordance with the provisions of this Section or other requirements.

C. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

D. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

E. The CONTRACTOR shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

F. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the CONTRACTOR shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

G. The CONTRACTOR shall dispose of water from the WORK in a suitable manner without damage to adjacent property. CONTRACTOR shall be responsible for obtaining any permits that may be necessary to dispose of water.

H. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

I. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the WORK and all costs thereof shall be included in the various contract prices in the Bid Forms, unless a separate bid item has been established for dewatering.

END OF SECTION

SECTION 31 30 00 - EARTHWORK

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall perform earthwork as indicated and required for construction of the WORK, complete and in place, in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Gradation Analyses

1. The CONTRACTOR shall submit gradation analyses of materials proposed for the WORK in conformance with the requirements of Section 01 33 00 – Contractor Submittals

2. Gradation analyses shall be as determined by a recognized testing laboratory.

C. Testing Laboratory

1. Qualifications Data: For the testing agency firm and persons specified in the Quality Assurance paragraph to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Owners and Clients, laboratory certifications and other information.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General

1. Fill, backfill, and embankment materials shall be selected or shall be processed and clean fine earth, rock, gravel, or sand, free from grass, roots, brush, other vegetation and organic matter.

2. Fill and backfill materials that are to be placed within 6-inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3-inches.

B. Suitable Materials

1. Materials not defined below as unsuitable will be considered as suitable materials and may be used in fills, backfilling, and embankment construction, subject to the indicated requirements.

2. If acceptable to the ENGINEER, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.

3. Mixing or blending of materials to obtain a suitable composite is the CONTRACTOR's option but is subject to the approval of the ENGINEER.

4. Suitable materials may be obtained from on-Site excavations, may be processed on-Site materials, or may be imported.

5. If imported materials are required by this Section or are required in order to meet the quantity requirements of the WORK, the CONTRACTOR shall provide the imported materials as part of the WORK.

C. The following types of materials are defined:

1. Type A (three-quarters inch minus granular backfill): Crushed rock or gravel, and sand with the gradation requirements below. The material shall have a minimum sand equivalent value of 28 and a minimum R-value of 78. If the sand equivalent value exceeds 35 the R-value requirement is waived.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 12

2. Type B (Class I crushed stone): Manufactured angular, crushed stone, crushed rock, or crushed slag with the following gradation requirements. The material shall have a minimum sand equivalent value of 75.

Sieve Size	Percentage Passing
3/4-inch	100
No. 4	30 - 50
No. 200	0 - 5

3. Type C (sand backfill): Sand with 100 percent passing a 3/8-inch sieve, at least 90 percent passing a Number 4 sieve, and a sand equivalent value not less than 30.

4. Type D: Not used

5. Type E (pea gravel backfill): Crushed rock or gravel with 100 percent passing a 1/2-inch sieve and not more than 10 percent passing a Number 4 sieve.

6. Type F (coarse drainrock): Crushed rock or gravel meeting the following gradation requirements:

Sieve Size	Percentage Passing
2-inch	100
1-1/2 inch	90 - 100

1-inch	20 - 55
3/4-inch	1 - 15
No. 200	0 - 3

7. Type G (aggregate base): Crushed rock aggregate base material of such nature that it can be compacted readily by watering and rolling to form a firm, stable base for pavements. At the option of the CONTRACTOR, the grading for either the 1-1/2 inch maximum size or 3/4-inch maximum size gradation shall be used. The sand equivalent value shall be not less than 22, and the material shall meet the following gradation requirements:

	Percentage Passing	
Sieve Size	**1-1/2 inch Max Gradation**	**3/4-inch Max Gradation**
2-inch	100	-
1-1/2-inch	90 - 100	-
1-inch	-	100
3/4-inch	50 - 85	90 – 100
No. 4	25 - 45	35 – 55
No. 30	10 - 25	10 – 30
No. 200	2 - 9	2 – 9

8. Type H (graded drain rock): Drain rock shall be crushed rock or gravel, durable and free from slaking or decomposition under the action of alternate wetting or drying. The material shall be uniformly graded and shall meet the following gradation requirements:

Sieve Size	**Percentage Passing**
1-inch	100
3/4-inch	90 – 100
3/8-inch	40 – 100
No. 4	25 – 40
No. 8	18 – 33
No. 30	5 – 15

No. 50	0 – 7
No. 200	0 – 3

9. The drain rock shall have a sand equivalent value not less than 75. The finish graded surface of the drain rock immediately beneath hydraulic structures shall be stabilized to provide a firm, smooth surface upon which to construct reinforced concrete floor slabs. The CONTRACTOR shall use, at its option, one of the asphalt types listed below:

	Type 1	**Type 2**	**Type 3**
Designation	SC-800	SC-250	RS-1
Spray Temperature, deg F	175-255	165-200	70-120
Coverage, gal/sq yd	0.50	0.50	0.50

If the surface remains tacky, sufficient sand shall be applied to absorb the excess asphalt.

10. Type I (Structural Fill): Structural fill meeting the following requirements:

    a. It shall consist of a minus 2-inch material with a minimum of 15 passing the No. 200 sieve.

    b. Maximum plasticity index of 30

    c. Maximum water-soluble sulfate conent 0.10 percent

    d. Maximum swell potential of 1% when compacted to a minimum density of 97-percent (ASTM D698) and moisture content of 1 percent below optimum and inundated under a surcharge load of 500 psf.

11. Type J (cement-treated backfill): Material which consists of Type H material, or any mixture of Types B, C, G, and H materials which has been cement-treated so that the cement content of the material is not less than 5 percent by weight when tested in accordance with ASTM D 2901 - Standard Test Method for Cement Content of Freshly Mixed Soil Cement. The ultimate compressive strength at 28 days shall be not less than 400 psi when tested in accordance with ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil - Cement Cylinders.

12. Type K (topsoil): Stockpiled topsoil material which has been obtained at the Site by removing soil to a depth not exceeding 2 feet. Removal of the topsoil shall be done after the area has been stripped of vegetation and debris.

13. Type L (controlled low strength material): Controlled low strength material shall be in accordance with Section 03 34 00 - Controlled Low Strength Material.

14. Type M (aggregate subbase): Crushed rock aggregate subbase material that can be compacted readily by watering and rolling to form a firm stable base. The sand

equivalent value shall be not less than 18 and the material shall meet the following gradation requirements:

Sieve Size	Percentage Passing
3-inch	100
2-1/2 inch	87 - 100
No. 4	35 - 95
No. 200	0 - 29

15. Soils which, when classified under ASTM D 2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classifications of Pt, OH, CH, MH, or OL shall be classified as unsuitable.

D. Schedule: Materials shall be used as indicated below:

Pipe	
Mortar coated, concrete, uncoated DIP	A, B
PVC	B
Trench zone backfill except as identified below	I, A through H or mixture thereof.
Final backfill under paved areas	G
Final backfill unpaved areas	K
Trench and final backfill under structures	Same as pipe zone except where concrete encasement is required
Aggregate base materials	G
Aggregate subbase	M
Backfill around structures	I, A through H or mixture thereof
Under hydraulic or water retaining structures with underdrains	H
All other structures	G,H

PART 3 --

3.1 MATERIALS TESTING

A. Samples

1. Soils testing of samples submitted by the CONTRACTOR will be performed by a testing laboratory of the OWNER's choice and at the CONTRACTOR's expense.

2. The ENGINEER may direct the CONTRACTOR to supply samples for testing of any material used in the WORK.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

C. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

D. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

2. The CONTRACTOR shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

3.2 IDENTIFICATION TAPE

A. Unless otherwise indicated, identification tape shall be placed above buried pipelines that are not comprised of magnetic components at least in part.

B. Identification tape shall be 6-inches wide, yellow in color, composed of polyethylene, and provided with an integral metallic wire.

C. Tape shall be labeled with CAUTION – BURIED UTILITIES.

PART 4 -- EXECUTION

4.1 EXCAVATION AND BACKFILLING - GENERAL

A. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the WORK.

2. The removal of such materials shall conform to the lines and grades indicated or ordered.

3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.

4. The CONTRACTOR shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.

5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable state safety requirements and the requirements of OSHA Safety and Health Standards for Construction (29CFR1926).

B. Removal and Exclusion of Water

1. The CONTRACTOR shall remove and exclude water, including stormwater, groundwater, irrigation water, and wastewater, from excavation in accordance with Section 31 23 19 – Dewatering.

4.2 OVER-EXCAVATION

A. Indicated

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be installed to the grade indicated.

B. Not Indicated

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the CONTRACTOR shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. Neither Indicated nor Ordered

1. Any over-excavation carried below the grade that is neither ordered or nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the WORK

4.3 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the CONTRACTOR.

B. The CONTRACTOR shall be responsible for the removal and disposal of excess excavated material.

C. Material shall be disposed of at an approved on-Site disposal area or off-Site at a location arranged by the CONTRACTOR in accordance with laws and regulations regarding the disposal of such material.

4.4 BACKFILL

A. General

1. Backfill shall not be dropped directly upon any structure or pipe.

2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for drainrock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. Pre-Placement Conditions

1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.

2. Trench sidewalls shall consist of excavated surfaces that are in a relatively undisturbed condition before placement of backfill materials.

D. Layering

1. Backfill materials shall be placed and spread evenly in layers.

2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that when compacted each layer shall not exceed 6 inches in thickness.

E. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

F. Moisture Content

1. Where the backfill material moisture content is below the optimum moisture content, water shall be added before or during spreading until the proper moisture content is achieved.

2. Where the backfill material moisture content is too high to permit the indicated degree of compaction, the material shall be dried until the moisture content is satisfactory.

4.5 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

A. Excavation Beneath Structures and Embankments

1. Except where indicated otherwise for a particular structure or where ordered by the ENGINEER, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.

2. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.

3. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the CONTRACTOR.

4. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

B. Excavation Beneath Paved Areas

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.

2. After the required excavation has been completed, the top 12-inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain 95 percent of maximum density.

3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.

4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

C. Notification of OWNER

1. The CONTRACTOR shall notify the OWNER at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the ENGINEER a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

D. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill materials as defined herein, where the material is graded such that 10 percent or more passes a No. 4 sieve, shall be mechanically compacted to the indicated percentage of density.

2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.

3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

E. Heavy Equipment

1. Equipment weighing more than 10,000 pounds shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.

2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

F. Layering

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.

2. Each layer shall be moistened and aerated as necessary.

3. Unless otherwise approved by the ENGINEER, no layer shall exceed 6 inches of compacted thickness.

4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

G. Embankments and Fills

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.

2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.

3. Material thus cut shall be re-compacted along with the new material.

4. Hillside or fill slopes 4:1 or flatter shall be prepared in accordance with Paragraph A, above.

H. Compaction Requirements

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve:

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Topsoil	80	NA
Aggregate base or subbase	95	NA

4.6 PIPELINE AND UTILITY TRENCH EXCAVATION AND BACKFILL

A. General

1. Unless otherwise indicated or ordered, excavation for pipelines and utilities shall be open-cut trenches with minimum widths as indicated.

B. Trench Bottom

1. Except where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe.

2. Excavations for pipe bells and welding shall be made as required.

3. Where pipe bedding is required, the bottom of the trench shall be excavated uniformly to the grade of the bottom of the pipe bedding.

C. Open Trenches

1. The maximum amount of open trench permitted in any one location shall be 500 feet or the length necessary to accommodate the amount of pipe installed in a single Day, whichever is greater.

2. Trenches shall be fully backfilled at the end of each Day or, in lieu thereof, shall be covered by heavy steel plates adequately braced and capable of supporting vehicular traffic in those locations where it is impractical to backfill at the end of each Day.

3. These requirements for backfilling or use of steel plate will be waived in cases where the trench is located further than 100 feet from any traveled roadway or occupied structure; in such cases, however, barricades and warning lights meeting appropriate safety requirements shall be provided and maintained.

D. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.

4. The CONTRACTOR shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

E. Placing and Spreading Of Backfill Materials

1. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 4 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of achieving the required density in 2 passes and that is acceptable to the ENGINEER.

2. Where such materials are used for pipe zone backfill, vibratory compaction shall be used at vertical intervals of the lesser of:

   a. one-half the diameter of the pipe; or

   b. 24-inches, measured in the uncompacted state.

3. In addition, these materials shall be subjected to vibratory compaction at the springline of the pipe and the top of the pipe zone backfill, regardless of whether that dimension is less than 24-inches or not.

4. Each layer of backfill material with greater than 10 percent passing the No. 4 sieve shall be compacted using mechanical compactors suitable for the WORK.

5. The material shall be placed and compacted under the haunch of the pipe and up each side evenly so as not to move the pipe during the placement of the backfill.

6. The material shall be placed in lifts that will not exceed 6-inches when compacted to the required density.

F. Mechanical Compaction

1. Backfill around and over pipelines that is mechanically compacted shall be compacted using light, hand-operated vibratory compactors and rollers that do not damage the pipe.

2. After completion of at least 2 feet of compacted backfill over the top of pipeline, compaction equipment weighing no more than 8,000 pounds may be used to complete the trench backfill.

G. Pipe And Utility Trench Backfill

1. Pipe Zone Backfill

a. Definitions

1) The pipe zone is defined as that portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane at a point above the top surface of the pipe as indicated.

2) The bedding is defined as that portion of pipe zone backfill material between the trench subgrade and the bottom of the pipe.

3) The embedment is defined as that portion of the pipe zone backfill material between the bedding and a level line as indicated.

b. Final Trim

1) After compacting the bedding, the CONTRACTOR shall perform a final trim using a stringline for establishing grade, such that each pipe section when first laid will be continually in contact with the bedding along the extreme bottom of the pipe.

2) Excavation for pipe bells and welding shall be made as required.

c. The pipe zone shall be backfilled with the indicated backfill material.

d. Pipe zone backfill materials shall be manually spread evenly around the pipe, maintaining the same height on both sides of the pipe such that when compacted the pipe zone backfill will provide uniform bearing and side support.

e. The CONTRACTOR shall exercise care in order to prevent damage to the pipeline coating, cathodic bonds, and the pipe itself during the installation and backfill operations.

2. Trench Zone Backfil

a. After the pipe zone backfill has been placed, backfilling of the trench zone may proceed.

b. The trench zone is defined as that portion of the vertical trench cross-section lying as indicated between a plane above the top surface of the pipe and a plane at a point 18-inches below the finished surface grade, or if the trench is under pavement, 18-inches below the roadway subgrade.

3. Final Backfill

a. Final backfill is defined as backfill in the trench cross-sectional area within 18-inches of finished grade, or if the trench is under pavement, backfill within 18-inches of the roadway subgrade.

H. Identification Tape

1. Install identification tape as indicated.

2. Terminate the tape in a precast concrete box either adjacent to or part of the valve box, manhole, vault, or other structure into which the non-metallic pipe enters or at the end of the non-metallic pipeline.

3. The termination box shall be covered with a cast iron lid.

4. The box shall be located at grade in paved areas or 6-inches above grade in unpaved areas.

I. Trench Shield

1. If a moveable trench shield is used during backfill operations, the shield shall be lifted to a location above each layer of backfill material prior to compaction of the layer.

2. The CONTRACTOR shall not displace the pipe or backfill while the shield is being moved.

J. Compaction Requirements

1. The following compaction test requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort (56,000 ft - lbf/ft^3) (2,700 kN-m/m^3) where the material is graded such that 10 percent or more passes a No. 4 sieve, and in accordance with ASTM D 4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density where the material is coarse granular backfill materials with less than 10 percent passing the No. 4 sieve.

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe embedment backfill for flexible pipe.	95	70

Pipe bedding and over-excavated zones under bedding for flexible pipe, including trench plugs.	95	70
Pipe zone backfill portion above embedment for flexible pipe	95	70
Pipe embedment backfill for rigid pipe	90	55
Pipe zone backfill portion above embedment for rigid pipe.	95	70
Pipe bedding and over-excavated zones under bedding for rigid pipe.	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	55
Trench zone backfill, beneath paved areas and structures, including trench plugs.	95	70
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	95	70

4.7 FIELD TESTING

A. General:

1. Field soils testing will be performed by a testing laboratory of the OWNER's choice at the OWNER's expense, except as indicated below.

B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D 1557.

2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.

3. Field density in-place tests will be performed in accordance with ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the ENGINEER.

C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the CONTRACTOR shall accomplish such remedy as may be required to ensure compliance.

2. Subsequent testing to show compliance shall be by a testing laboratory selected by the OWNER and paid by the CONTRACTOR.

D. CONTRACTOR's Responsibilities

1. The CONTRACTOR shall provide test trenches and excavations, including excavation, trench support and groundwater removal for the OWNER's field soils testing operations.

2. The trenches and excavations shall be provided at the locations and to the depths as required by the OWNER.

END OF SECTION

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SECTION 31 34 19 – GEOTEXTILES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide geotextiles, complete and in place, in accordance with the Contract Documents.

B. Definitions: The following definitions apply to the WORK of this Section:

1. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

2. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile provided.

3. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile provided.

4. Nondestructive Sample: Sample representative of finished geotextile, prepared for testing without destruction of geotextile.

5. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

6. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D 4884.

7. Woven geotextile: A geotextile fabric composed of polymeric yarn interlaced to form a planar structure with uniform weave pattern.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The following standards are referenced in this Section:

ASTM D 4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
ASTM D 4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D 4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D 4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

ASTM D 4884	Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Sewn Geotextiles
ASTM D 4886	Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer material specifications and product literature.

2. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.

3. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

C. Samples

1. Geotextile: One-piece, minimum 18-inches long, taken across full width of roll of each type and weight of geotextile. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.

2. Field Sewn Seam: 5-foot length of seam, 12-inches wide with seam along center, for each type and weight of geotextile.

3. Securing Pin and Washer: 1 each.

D. Certifications

1. Certification from geotextile manufacturer that products satisfy the indicated requirements.

2. Field seam efficiency test results.

PART 2 -- PRODUCTS

2.1 NONWOVEN GEOTEXTILE

A. Nonwoven geotextile shall be composed of a pervious sheet of polymeric fibers interlaced to form a planar structure with uniform random fiber pattern. Products shall be calendared or finished so that yarns will retain their relative position with respect to each other.

B. Polymeric yarn shall be long-chain synthetic polymers (polyester, polypropylene, or polyethylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.

C. Geotextile Edges: Selvaged or finished to prevent outer material from separating from sheet.

D. Unseamed Sheet Width: Minimum 6-feet.

E. Nominal Weight per Square Yard: 12 ounces.

F. Physical Properties: Conform to requirements below.

PHYSICAL PROPERTY REQUIREMENTS FOR NONWOVEN GEOTEXTILE		
Property	Requirement	Test Method
Apparent Opening Size (AOS)	No. 100 to No. 140 U.S. Standard Sieve Size	ASTM D 4751
Water Permittivity	1.2 $sec.^{-1}$, MinARV	ASTM D 4491 (Falling Head)
Vertical Waterflow Rate	90 gpm/sq ft, MinARV	
Wide Width Strip Tensile Strength	300 MinARV	ASTM D 4595
Wide Width Strip Elongation	70 percent, MaxARV	ASTM D 4595
Trapezoidal Tear Strength	120 lb, MinARV	ASTM D 4533
Puncture Strength	130 lb, MinARV	ASTM D 4833
Ultraviolet Radiation Resistance	90 percent strength retention, MinARV after 500 hours	ASTM D 4355

2.2 SEWING THREAD

A. Sewing thread shall be polypropylene, polyester, or Kevlar thread with durability equal to or greater than durability of geotextile sewn.

2.3 SECURING PINS

A. Securing pins shall be steel rods or bars conforming to the following:

1. 3/16-inch diameter.

2. Pointed at one end; head on other end, sufficiently large to retain washer.

3. Minimum Length: 12-inches.

B. Steel washers for securing pins shall be:

1. Outside Diameter: Not less than 1-1/2 inches.

2. Inside Diameter: 1/4-inch.

3. Thickness: 1/8-inch.

C. Steel Wire Staples

1. U-shaped.

2. 10-gauge.

3. Minimum 6-inches long.

PART 3 -- EXECUTION

3.1 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify manufacturer and product name or number.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in a way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

3.2 LAYING GEOTEXTILE

A. Notify the ENGINEER whenever geotextiles are to be placed. Do not place geotextile prior to obtaining ENGINEER's approval of underlying materials.

B. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.3 ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and extend at least 18-inches beyond toe of slope.

3.4 JOINTS

A. Unseamed Joints

1. Unseamed joints shall be overlapped to the following dimensions unless otherwise indicated:

a. Foundation/Subgrade Stabilization: Minimum 18-inches.

b. Riprap: Minimum 18-inches.

c. Drain Trenches: Minimum 18-inches, except overlap shall equal trench width if trench width is less than 18-inches.

d. Other Applications: Minimum 12-inches.

B. Sewn seams shall be used wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by ENGINEER, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam efficiency shall be minimum 70 percent, verified by preparing and testing minimum of one set of nondestructive samples per acre of each type and weight of geotextile provided. Test according to ASTM D 4884.

2. Type: "J" type seams are preferred, but flat or butterfly seams are acceptable.

3. Stitch Count: Minimum 3 to maximum 7 stitches per inch.

4. Stitch Type: Double-thread chainstitch, Type 401, Federal Standard No. 751a.

5. Stitch Location: 2-inches from geotextile sheet edges, or more if necessary to develop required seam strength.

6. Sewing Machines: Capable of penetrating 4 layers of geotextile.

3.5 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sand bags or other means approved by ENGINEER.

B. Securing Pins

1. Insert securing pins with washers through geotextile, midway between edges of overlaps and 6-inches from free edges.

2. Spacing

Slope	Maximum Pin Spacing, feet
Steeper than 3:1	2
3:1 to 4:1	3
Flatter than 4:1	5

3. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.

4. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

3.6 PLACING PRODUCTS OVER GEOTEXTILE

A. Notify ENGINEER before placing material over geotextile,. Do not cover installed geotextile prior to receiving authorization from the ENGINEER to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as indicated below.

3.7 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way that will completely envelope granular drain material to be placed in trench and with indicated overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to grade, fold geotextile over top of granular drain material, unless otherwise indicated. Maintain overlap until overlying fill or backfill is placed.

3.8 SILT FENCE APPLICATIONS

A. Install geotextile in one piece or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

C. Securely fasten geotextile to a wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

D. Promptly repair or replace silt fence that becomes damaged.

3.9 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile. Repair damaged geotextile by placing patch of undamaged geotextile over damaged area plus at least 18-inches in all directions beyond damaged area. Remove interfering material as necessary to expose damaged geotextile for repair. Sew patches or secure them with pins and washers, as indicated above for securing geotextile, or by other means approved by ENGINEER.

3.10 REPLACING CONTAMINATED GEOTEXTILE

A. Protect geotextile from contamination that would interfere, in ENGINEER's opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

END OF SECTION

SECTION 31 90 00 – GRAVITY RETAINING WALLS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall furnish and install gravity retaining walls in conformance with the lines and grades shown in the Contract Documents.

B. The retaining walls shall consist of non-structural leveling pads, concrete, segmental blocks, unit/drainage fill, and select reinforced fill if required in the final engineered wall design. The wall shall be constructed using select granular backfill materials as defined in this Section.

C. In addition to soil loading, the retaining wall shall be designed to withstand HS-20 surcharge traffic loading in the roadway.

D. Where indicated the Contract Documents, the retaining wall top block shall have pre-cast sleeves for chain-link fence posts. Fence posts shall be grouted into the top block during construction. The retaining wall shall be designed to withstand standard fence loads applied by these embedded posts.

E. Design for the block units are based on ReCon “Series 50” retaining wall units. Contractor shall notify the ENGINEER before the submittal phase if a substitution to this style retaining wall is proposed.

F. The retaining wall shall be designed, at minimum, to meet the following loading conditions:

Active Soil Pressure (lateral),	40 pcf
Soil Bearing Pressure,	1,500 psf
Friction Coefficient	0.45
Fence Loads	90 mph wind, Exp C
Seismic Response Spectra	Ss = 0.89, S1 = 0.31

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Contractor shall submit a Manufacturer's certification, prior to start of work, that the retaining wall system components meet the requirements of this specification and the structural design.

C. Contractor shall submit construction drawings and design calculations, which shall include all details, dimensions, quantities and cross-sections necessary to construct the wall and shall include but shall not be limited to the following:

1. An elevation view for each wall which shall include the top of wall elevation at all horizontal and vertical break points and at least every 50 feet along the face of wall; the elevation of all steps in the foundation; designation as to the type, size, and length of concrete, segmental blocks and the distance along the face of the wall to

where changes in height of the wall occur; and an indication of the final ground line and maximum calculated bearing pressures.

2. Types, locations, and properties of all drainage materials, appurtenances and special installation requirements not covered in this specification.

3. Design calculations, including design assumptions, for structural analysis of sliding and overturning.

4. A typical cross section or cross sections showing the elevation relationship between ground conditions and proposed grades.

5. General notes pertaining to design criteria and wall construction.

D. Submit gradation reports for aggregates used for the wall leveling pad, unit / drainage fill and for select reinforced fill if required in the final engineered wall design.

E. Submit product data proposed sealer or anti-graffiti coating.

F. All submittals must be provided and reviewed prior to the start of retaining wall construction.

1.3 QUALITY ASSURANCE

A. Contractor shall inspect all products at delivery to determine that the proper materials have been delivered and are useable. Damaged material shall not be incorporated into the work.

B. Block units shall be stored in a location and manner that protects against excessive weathering and damage.

C. Contractor shall prevent block units from excessive soiling and coming in contact with substances which may stain or adhere to the finished visual surfaces of the unit.

D. All individual ULTRABLOCK TM units shall be free of cracks and other defects that would interfere with the placement and locking of units. All shear keys shall be in good condition.

1.4 GENERAL

A. Any attachment devices, fasteners, and joint materials in addition to the materials covered by this section of the specification shall be included as necessary incidentals from a single wall system supplier.

1.5 CONCRETE, SEGMENTAL BLOCK UNITS

A. The block units shall have 28-day compressive strength of at least 2,200 psi. The maximum absorption of 10 pcf and adequate freeze-thaw protection (absorption by weight 6%) shall, in general, satisfy the local requirements of high elevation (mountainous) areas where there is a potential for spalling due to freeze-thaw. Concrete, segmental block units used shall maintain tolerances of:

1. Height: +/- 3/16”

2. Width: +/- 1/2” unless field cut for fitting purposes.

3. Depth: No less than the unit design depth with the textured face portion of the block considered as 4”.

B. Face Texture: The OWNER may select up to two textures and the contractor shall provide a single block of each texture for final selection of the preferred style by the OWNER. Contactor shall provide both blocks in a size that can be used as part of a base layer so that the block texture not selected can be utilized but will not be visible at the completion of construction.

C. Sealing: Block units shall be sealed with an approved sealer or anti-graffiti coating such as:

1. TK Products TK-290 TRI-SILOXANE OTC (sealer)

2. TK Products 1496 TK Permaclean OTC (anti-graffiti)

1.6 BASE LEVELING PAD

A. The wall base leveling pad material shall consist of a minimum 6-inch layer or Type A or Type M compacted crushed stone base or Type L non-reinforced concrete in accordance with Section 31 30 00 - Earthwork. The leveling pad shall extend a minimum 6 inches in front and behind the actual location of the base units along their designated placement.

1.7 DRAIN ROCK: Drain rock shall consist of free-draining, all-weather, coarse-grained materials and comply with ASTM D 422 and in accordance with Section 31 30 00 – Earthwork.

1.8 BACKFILL MATERIALS: Provide backfill in accordance with Section 31 30 00 – Earthwork.

1.9 DRAINAGE PIPE:

A. Drainage pipe shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D-3034 or corrugated HDPE pipe manufactured in accordance with ASTM D-1248. Drainage pipe shall be covered with a geotextile filter fabric in accordance with Section 31 34 19 - Geotextiles.

B. Drainage pipe shall daylight at least every 50 feet along the length of the wall and at every low point in the wall, unless otherwise noted.

1.10 UNIT ADHESIVE:

Adhesive shall be a premium, construction grade suitable for concrete and exterior applications.

1.11 GEOTEXTILE: In all locations, provide non-woven geotextile filter fabric behind the drainage aggregate in accordance with Section 31 34 19 – Geotextiles.

1.12 Gravity Retaining Wall Manufacturers (or a licensed and authorized supplier thereof), or approved equal:

1. Ultrablock, Inc.

2. ReCon Wall Systems, Inc.

3. Redi-Rock International

PART 2 -- EXECUTION

2.1 EXAMINATION

A. Verify locations of utilities and existing structures prior to excavation.

B. Examine the Project site and evaluate conditions where the retaining wall will be constructed. Notify the proper supervising authority in writing of any conditions that may interfere with the proper construction of the wall or delay completion.

C. Promptly notify the wall design engineer of site conditions which may affect wall performance, soil conditions observed other than those assumed, or other conditions that may require a reevaluation of the wall design.

2.2 FOUNDATION PREPARATION

A. The Contractor will verify that layout dimensions are correct and the substrate is in proper condition for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Excavate to the lines and grades shown in the construction drawings.

C. Foundation soil shall be excavated and graded as required for base leveling pad dimensions shown on the construction drawings, or as directed by the wall engineer. Foundation soil shall be evaluated by a Geotechnical Engineer or Owner's Representative to ensure that the bearing soils meet or exceed the design conditions or assumptions. Compact foundation soil zone to 95% standard proctor prior to installing base leveling pad.

D. Any foundation soils found to be unsuitable shall be removed and replaced. Over-excavated areas shall be filled with suitable base or backfill material and compacted to 95% standard proctor density in accordance with Section 31 30 00 - Earthwork.

2.3 BASE LEVELING PAD

A. Base material shall be compacted so as to provide a smooth, hard surface on which to place the first course of units. Compact base material to 95% of standard proctor density.

B. Base shall be prepared to ensure full contact of the wall unit with base material. Spacing or gaps between units shall not exceed ½".

C. Contractor may elect to substitute a portion of the specified granular base materials with a lean, unreinforced concrete topping.

2.4 BLOCK INSTALLATION

A. First course of units shall be Base Block units and shall be placed in full contact with the base leveling pad with the aesthetic surface facing out and the front edges tight together.

B. Check units for level from side-to-side, front to back, and check to maintain unit batter front-to-back.

C. Place unit faces in contact side to side and avoid any gaps greater than ½".

D. Fill and compact fill to grade in front of embedded units prior to compaction behind the wall units.

E. Fill voids between units with 3/4" clean crushed rock to a distance of one foot behind the unit depth unless otherwise instructed in the Construction Drawings.

F. Sweep and clean the top of each course before setting additional courses.

G. Lay each successive course making sure that the bottom recess is in full contact with the unit locators of the course below. Pull unit forward as far as possible. Backfill and compact soil behind the units.

H. Check and maintain level and wall batter by use of shims when necessary.

I. Follow manufacturer's recommended procedures to maintain acceptable running bond when constructing curved walls and / or corners. Build in accordance with Construction Drawings or Manufacturer's construction detail drawings.

J. Handle units with proper lifting devices that have been certified for the loads associated with the weights of the units. Avoid applying forces to the lifting loops in excess of the normal force associated with the weight of the unit (i.e., avoid applying "shear forces" or "dynamic loads" from bouncing or swinging of a unit). If the unit is to be transported over a significant distance in the field, it is recommended that a CABLE be used, NOT A CHAIN. The cable has some "stretch" in it that will absorb some of the dynamic loads.

K. Tolerances:

1. Minimum width of the roadway as indicated on the plans must be adhered to.

2. Vertical alignment: +/- 1.5" over any 12 ft. distance and no more than +/- 3" over entire length of wall.

3. Wall Batter At Completion Of Work: +/- 2 degrees from the design batter and no batter less than 2 degrees.

4. Corners: +/- 1 foot to theoretical location indicated on the plans.

2.5 DRAIN ROCK PLACEMENT

A. Install a continuous layer of drain rock behind the retaining wall. The drain rock shall extend from the back face of the wall to a minimum 12" behind the largest block. Install drain rock with a non-woven geotextile filter fabric between the drain rock and the backfill in accordance with the requirements of this Section.

2.6 BACKFILL PLACEMENT

A. Wall fill material shall be placed in lifts no greater than 8" in depth and shall be less if necessary to achieve necessary compaction.

B. Backfill shall be compacted to 95% of standard proctor density.

C. Only hand-operated compaction equipment shall be used within 3 feet of the back of the block units.

D. Wherever possible, backfill should be placed beginning at the face of the wall. Backfill shall be placed, spread, and compacted in 10-inch lifts maximum in a manner that minimizes the development of wrinkles, folds or movement of the geogrid (if applicable).

E. At the conclusion of each day's work, slope backfill at both the crest and bottom of wall away from wall face to prevent surface drainage from scouring or ponding.

F. During wall construction, the Contractor shall be responsible for coordination of other project site operations so as to avoid adjacent construction site drainage from affecting wall construction area. Any wall materials which become damaged or disturbed during backfill placement shall be either removed and replaced at the Contractor's expense or corrected, as directed by the ENGINEER. The Contractor, at their expense, shall correct any misalignment or distortion of the wall facing due to placement of backfill outside the limits of this specification.

G. Upon completion of wall construction work, the Contractor shall:

1. Ensure finished grading directs normal drainage away from the finished wall.

2. Ensure other trades do not operate heavy equipment or excavate near the wall and reinforced soil zone.

2.7 SEALING

A. Provide samples of sealed faces for approval prior to commencing application to block units. Samples shall be large enough to demonstrate scope of color variation.

B. Install stain / sealer in accordance with manufacturers recommended procedures.

END OF SECTION

SECTION 32 11 13 - A.C. PAVEMENT AND BASE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide A.C. pavement and base, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AASHTO M 82	Cut-Back Asphalt (Medium Curing Type)
AASHTO M 140	Emulsified Asphalt
AASHTO M 208	Cationic Emulsified Asphalt
AASHTO M 226	Viscosity Graded Asphalt Cement
ASTM D 242	Mineral Filler for Bituminous Paving Mixtures
ASTM D 692	Coarse Aggregate for Bituminous Paving Mixtures
ASTM D 977	Emulsified Asphalt
ASTM D 1073	Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1188	Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
ASTM D 1557	Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf per cu ft)
ASTM D 2027	Cutback Asphalt (Medium Curing Type)
ASTM D 2397	Cationic Emulsified Asphalt
ASTM D 2726	Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
ASTM D 3381	Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3515	Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the ENGINEER.

B. Suitability Tests of Proposed Materials: Tests for conformance with the Specifications shall be performed prior to start of the WORK. The samples shall be identified to show

the name of the material, aggregate source, name of the supplier, contract number, and the segment of the WORK where the material represented by the sample is to be used. Results of all tests shall be submitted to the ENGINEER for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

C. Trial Batch: Before placing any paving material, a testing laboratory acceptable to the ENGINEER shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the CONTRACTOR for the work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the CONTRACTOR, and approved by the ENGINEER. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than 2 laboratory trial batch tests will be paid by the OWNER but the CONTRACTOR shall be responsible for the materials. Performing and paying for any additional trial batch testing shall be the CONTRACTOR's responsibility.

PART 2 -- PRODUCTS

2.1 AGGREGATE BASE

A. Materials for aggregate base shall be Type G material in accordance with Section 31 30 00 - Earthwork.

2.2 ASPHALT CEMENT

A. Asphalt Cement shall be Grade **AR-4000 or AR-8000** complying with the requirements of AASHTO M226 (ASTM D 3381).

2.3 MINERAL AGGREGATE

A. Mineral aggregate shall be crushed stone, crushed slag, crushed gravel, stone or slag screening, sand, mineral filler, or a combination of two or more of these materials. Coarse and fine aggregates shall comply with all the quality requirements, except soundness, of ASTM D 692 and D 1073, respectively. Coarse aggregate failing to comply with abrasion requirements may be used if experience has demonstrated it to be satisfactory.

B. Mineral filler shall comply with ASTM D 242.

C. Combinations of aggregates having a history of polishing shall not be used in surface courses.

2.4 ASPHALT-AGGREGATE MIXTURE

A. Base Course Mixture: The CONTRACTOR shall submit for approval a job-mix formula for each mixture. The job-mix formula for the asphalt-aggregate base course mixture shall be within the following limits:

Sieve Size	Total Percent Passing by Weight
2-inch	100
1-1/2 inch	100
1-inch	90-100
3/4-inch	-
1/2-inch	56-80
3/8-inch	-
No. 4	29-59
No. 8	19-45
No. 50	5-17
No. 200	1-7
Asphalt Content	3-9 percent by weight of total mix

B. Base Course Mixture Test Criteria: The asphalt-aggregate surface course mixture shall meet the following test criteria:

Stability (Marshall)	2,224 min
Flow (Marshall Method)	8-20
Air Voids	3-5 percent
Voids in Mineral Aggregate	14 percent

C. Surface Course Mixture: The job-mix formula for the asphalt-aggregate surface course mixture shall be within the following limits:

Sieve Size	Total Percent Passing by Weight
1-inch	100
3/4-inch	90-100
1/2-inch	-
3/8-inch	56-80
No. 4	35-65

No. 8	23-49
No. 50	5-19
No. 200	2-8
Asphalt Content	4-10 percent by weight of total mix

D. Surface Course Mixture Test Criteria: The asphalt-aggregate surface course mixture shall meet the following test criteria:

Stability (Marshall)	2,224 min
Flow (Marshall Method)	8-20
Air Voids	3-5 percent
Voids in Mineral Aggregate	16 percent

E. Asphalt-Aggregate Mixture Tolerances: The following tolerances for the job-mix formula will be allowed per single test:

Passing Sieve	Percent
1/2-inch and larger	plus and minus 8
3/8-inch and No. 4	plus and minus 7
No. 8	plus and minus 6
No. 50	plus and minus 5
No. 200	plus and minus 3
Asphalt Content, percent by weight of total mixture	plus and minus 0.5

Results of single extraction and sieve tests shall not be used as the sole basis for acceptance or rejection of the mixture. Any variation from the job-mix formula greater than the tolerances shown above shall be investigated and the conditions causing the variations corrected.

PART 3 -- EXECUTION

3.1 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 30 00 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section.

Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

3.2 AGGREGATE BASE

A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6-inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6-inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6-inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

3.3 ASPHALT CONCRETE

A. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

B. Asphalt concrete shall not be placed when the atmospheric temperature is below 40 degrees F or during unsuitable weather.

C. The asphalt concrete shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross section and grade of the course being constructed.

D. The depositing, distributing, and spreading of the asphalt concrete shall be accomplished in a single, continuous operation by means of a self-propelled mechanical spreading and finishing machine designed specially for that purpose. The machine shall be equipped with a screed or strike-off assembly capable of being accurately regulated and adjusted to distribute a layer of the material to a definite pre-determined thickness. When paving is of a size or in a location that use of a self-propelled machine is impractical, the ENGINEER may waive the self-propelled requirement.

E. Spreading, once commenced, shall be continued without interruption.

F. The mix shall be compacted immediately after placing. Initial rolling with a steel-wheeled tandem roller, steel three-wheeled roller, vibratory roller, or a pneumatic-tired roller shall follow the paver as closely as possible. If needed, intermediate rolling with a pneumatic-tired roller shall be done immediately behind the initial rolling. Final rolling shall eliminate marks from previous rolling. In areas too small for the roller, a vibrating plate compactor or a hand tamper shall be used to achieve thorough compaction.

G. Upon completion the pavement shall be true to grade and cross-section. When a 10-ft straightedge is laid on the finished surface parallel to the center of the roadway, the surface shall not vary from the edge of the straightedge more than 1/8-in except at intersections or changes of grade. In the transverse direction, the surface shall not vary from the edge of the straightedge more than 1/4-in.

H. The relative density after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

END OF SECTION

SECTION 32 31 13 – CHAIN LINK FENCING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide chain link fencing and gates and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Chain link fencing, gates, accessories, fittings, and fastenings shall be products of a single manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.

2. Scale layout of fencing, gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, barbed wire support arms; and other accessories which may be necessary.

C. Samples: Samples of proposed fence components, at least 12-inches long, to illustrate the selected color and finish.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Dimensions indicated herein for roll-formed pipe and H-sections are outside dimensions, excluding coatings.

B. Fence fabric height shall be 6-feet match surrounding fencing, unless otherwise indicated.

C. Fencing materials shall be hot-dip galvanized after fabrication.

D. Fencing shall be topped with 3 lines of barbed wire on single, 45 degree supporting arms, sloped outward.

2.2 STEEL FABRIC

A. Fence fabric shall be No. 9 gauge steel wire, 2-inch mesh, with top selvages knuckled and bottom selvages twisted and barbed.

B. Fabric Finish: Fabric shall be galvanized in conformance with ASTM A 392 - Zinc-Coated Steel Chain Link Fence Fabric, Class II, with not less than 2.0 ounces zinc per square foot of coated surface.

2.3 FRAMING AND ACCESSORIES

A. Steel Framework, General: Unless otherwise indicated, framework components shall be fabricated of galvanized steel conforming to ASTM A 53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, or ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, with not less than 1.8 ounces zinc per square feet of coated surface.

1. Fittings and accessories shall be galvanized in accordance with ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware, with zinc weights per Table I of that standard, except that no coating shall be less than 1.8-ounce zinc per square foot of coated surface.

B. End, Corner and Pull Posts: Posts shall be one-piece without circumferential welds, 3-inch schedule 40 pipe, 5.79 pounds per linear foot.

C. Line Posts: Line posts shall be spaced no more than 10-feet on center and shall be 2-1/4 inch “H” column section, 4.1-pounds per linear foot, or schedule 40, 2-1/2 inch pipe, 3.65-pounds per linear foot.

D. Gate Posts: Gate posts shall be 4-inch schedule 40 pipe, 9.1-pounds per linear foot.

E. Top Rail: Top railing shall be provided in manufacturer’s longest lengths, with expansion type couplings, approximately 6-inches long, for each joint. Fence design shall provide positive, secure attachment of top rail to each gate post, corner post, pull post and end post. Top rail and braces shall be 1-5/8 inch schedule 40 pipe, 2.27-pounds per linear foot, or 1-1/2 inch “H” column section, 2.00-pounds per linear foot.

F. Tension Wire: Tension wire shall be located at the bottom of the fabric and shall consist of No. 7 gauge coated coil spring wire of metal and finish to match fabric. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence. Tension wire attachment shall be with fabric tie wires at a spacing of no more than 24-inches apart.

G. Fabric Tie Wires: Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used. Ties shall be spaced 14-inches apart on posts and 24-inches apart on rails.

H. Post Brace Assembly: Post brace assembly shall be manufacturer’s standard adjustable brace assembly provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-inch diameter rod and adjustable tensioner.

I. Post Tops: Post tops shall be weather-tight closure caps, designed for containment of top rail and positive permanent attachment to post. One cap shall be provided for each post.

J. Stretcher Bars: Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16-inch by 3-1/2 inch. One stretcher bar shall be provided for each gate and end post, and 2 for each corner and intermediate brace post.

K. Stretcher Bar Bands: Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8-inch by 3/4-inch. Stretcher bar bands shall be spaced no more than 15-inches on center.

L. Barbed Wire Supporting Arms: Supporting arms shall be manufacturer's standard fabrication, of metal and finish to match fence framework, with provision for anchorage to each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap. Supporting arm shall be single 45-degree arm type and shall be capable of withstanding 250 pounds of downward pull at outermost end.

M. Barbed Wire: Barbed wire shall be 2-strand, No. 12-1/2 gauge zinc-coated steel or iron wire with four-point, 14-gauge barbs spaced no more than 5-inches apart.

2.4 GATES

A. Fabrication: Perimeter frames of gates shall be fabricated from same metal and finish as fence framework. Gate frames shall be assembled by welding or with fittings and rivets for rigid, secure connections. Welds shall be ground smooth. Gate frames and any ungalvanized hardware, shall be hot-dip galvanized after fabrication. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric, hardware and shall be hot-dip galvanized after fabrication.

1. Fabric for gates shall match fence fabric, unless otherwise indicated. Fabric shall be installed with stretcher bars at all perimeter edges. Stretcher bars shall be attached to gate frame with stretcher bar bands spaced no more than 15-inches on center.

2. Each gate shall be diagonally cross-braced with a 3/8-inch diameter adjustable length truss rod to ensure frame rigidity without sag or twist.

3. Where barbed wire is indicated above gates, vertical members shall be extended and fabricated as required to receive barbed wire supporting arms.

B. Swing Gates: Perimeter frames of swing gates shall be constructed of the same pipe or "H" column members as the top rails and shall be fabricated by welding. Welds shall be ground smooth prior to hot-dip galvanizing.

1. Hardware and accessories shall be provided for each gate, galvanized in conformance with ASTM A 153, and in accordance with the following:

a. Hinges: Hinges shall be of size and material to suit gate size, non-lift-off type, offset to permit 180-degree gate opening. Two hinges shall be provided for each leaf less than 6 feet in height.

b. Latch: Latch shall be forked type or plunger-bar type, permitting operation from either side of the gate, with padlock eye as an integral part of the latch.

c. Keeper: Keeper shall be provided which automatically engages the gate leaf and holds it in the open position until it is manually released.

d. Double Gates: Gate stops shall be provided for double gates, consisting of mushroom type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar. Locking device and padlock eyes shall be provided as an integral part of the latch, permitting both gate leaves to be locked with a single padlock.

2.5 RELATED ITEMS

A. Concrete: Concrete shall be provided according to Section 03 31 00 - Cast-In-Place Concrete.

B. Nuts, bolts and screws shall be steel, minimum size 3/8-inch diameter, hot-dip galvanized after fabrication.

2.6 MANUFACTURERS

A. Manufacturer's Qualifications: Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years.

B. Installer's Qualifications: Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

C. Manufacturers, or equal

1. **American Fence Corp.**

2. **Anchor Fence, Inc.**

3. **United States Steel**

PART 3 -- EXECUTION

3.1 INSPECTION

A. Prior to commencing installation, require Installer to inspect all areas and conditions within which WORK of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

3.2 INSTALLATION

A. General: Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations which are designed by an engineer to safely accommodate the loads to which they will be subjected.

B. Excavation: Holes for posts shall be drilled or hand excavated to the diameters and spacings indicated, in firm, undisturbed or compacted soil. Post foundations which are not designed by an engineer shall comply with the following:

1. Holes shall be excavated to a diameter not less than 12-inches or not less than 5 times the largest dimension of the item being anchored, whichever is larger.

2. Depth for holes shall be not less than 40-inches; excavated approximately 4-inches lower than the post bottom, with bottom of posts set not less than 36-inches below finish grade surface.

C. Setting Posts: Line posts shall be spaced at not more than 10-foot intervals, measured from center to center of the posts, parallel to the ground slope. Posts shall be set plumb

and shall be centered in holes, 4-inches above the bottom of the excavation, with posts extending not less than 36-inches below finish grade surface.

1. Corner posts shall be installed where changes in the fence lines equal or exceed 15 degrees, measured horizontally.

2. Each post shall be properly aligned vertically and its top aligned parallel to the ground slope. Posts shall be maintained in proper position during placement and finishing operations.

D. Concrete

1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.

2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.

3. Concrete footings shall have a neat appearance and shall be extended 2-inches above grade and troweled to a crown to shed water.

4. A minimum of 7 days shall elapse after placing the concrete footings before the fence fabric or barbed wire is fastened to the posts.

E. Bracing: Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. Diagonal tension members shall connect tautly between posts below horizontal braces.

1. Braces shall be so installed that posts remain plumb when diagonal rod is under proper tension.

F. Intermediate Brace Posts: Where straight runs of fencing exceed 500-feet, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required, such that the spacing between intermediate brace posts does not exceed 500-feet. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

G. Top Rails: Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

H. Tension Wire: Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts. Tension wire shall be installed on a straight grade between posts, with approximately 2-inches of space between finish grade and bottom selvage, unless otherwise indicated. Tension wire shall be tied to each post with not less than 6 gauge galvanized wire.

I. Fabric

1. Chain-link fabric shall be fastened on the secured side of the posts.

2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.

3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

J. Tie Wires: Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.

1. Fabric shall be tied to line posts with tie wires spaced at 12-inches on center.

2. Fabric shall be tied to rails and braces with tie wires spaced at 24-inches on center.

3. Fabric shall be tied to tension wires, with hog rings spaced 24-inches on center.

K. Stretcher Bars: Fabric shall be fastened to end, corner, intermediate brace, and gate posts with stretcher bars. Bars shall be threaded through or clamped to fabric at 4-inches on center and secured to posts with stretcher bar bands spaced no more than 14-inches on center.

L. Fasteners: Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

M. Galvanized coating damaged during construction of the fencing shall be repaired by application of Galvo-Weld; Galvinox; or equal.

END OF SECTION

SECTION 33 05 16 - PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 -- GENERAL

1.1 THE SUMMARY

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

1.2 SPECIFICATIONS, CODES AND STANDARDS

ASTM A 48	Gray Iron Castings
ASTM C 150	Portland Cement
ASTM C 478	Precast Reinforced Concrete Manhole Sections
ASTM C 890	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C 923	Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.3 CONTRACTOR SUBMITTALS

A. **General:** Furnish submittals in accordance with Section 01 33 00 – Contractor SubmittalS.

B. Shop Drawings

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.

2. Structural design calculations for vaults, signed by a registered engineer.

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

D. **Manufacturer's Test Results:** Pull out force for manhole steps.

1.4 QUALITY ASSURANCE

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

PART 2 -- PRODUCTS

2.1 MANHOLES

A. The CONTRACTOR shall provide precast manhole sections and conical sections conforming to ASTM C 478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. **Design Criteria:** Manhole walls, transitions, and base shall be designed per ASTM C 478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 120 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches or one-half of the diameter of the smaller penetration, whichever is greater.

D. Joints shall be sealed with o-ring gaskets conforming to ASTM C 443.

E. Concrete for base and channel formation shall be 4500 psi concrete conforming to Section 03 31 00 - Cast-In-Place Concrete.

F. Barrel section to pipe connections shall be sealed with resilient connectors complying with ASTM C 923. Mechanical devices shall be stainless steel.

G. Manhole steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches. Furnish test results demonstrating step capability to resist a pull out force of 2200 pounds. Provide **PS2-PF Manhole Step** by **M.A. Industries,** or equal.

H. Manhole Manufacturers, or Equal

1. **Oldcastle Infrastructure**

2. **H2 Pre-Cast**

2.2 FRAMES AND COVERS

A. **Castings:** Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 30 inches in diameter. Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers, or Equal

1. **Alhambra Foundry Co., Ltd.**

2. **Neenah Foundry Co.**

3. **Vulcan Foundry, Inc**

2.3 VAULTS

A. The CONTRACTOR shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,500 psi. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

	L	=	90h, plus surcharge of 240 psf in areas of vehicular traffic
Where	L	=	loading in psf
	h	=	depth of fill in feet

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

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports.

F. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch between edges will be accepted. All covers, except round, heavy-weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

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

PART 3 -- EXECUTION

3.1 GENERAL

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

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

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

D. Ladder shall be driven into tapered holes formed in the concrete by inserts from the ladder manufacturer or 1-inch holes drilled 3-3/4 inches deep into the manhole wall in the field. No more than 6-1/8 inches of plastic arm, measured on the inside of the step, shall be exposed outside the concrete.

E. Ladder shall be installed 12-inches on centers vertically, not more than 1/2 inch out of plumb. The top step shall be no more then 12-inches below the manhole cover.

END OF SECTION

SECTION 33 05 31.11 – PVC GRAVITY SEWER PIPE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide PVC solid wall non pressure pipe and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. This Section covers pipe from 4-in to 60-in diameter nominal size, for use in storm sewer, sanitary sewer, or other non-pressure sewer applications.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 74 20	Gravity Pipeline Testing
01 77 00	Project Closeout
31 30 00	Earthwork
33 05 05.32	Gravity Pipeline Testing

B. Reference Standards

American Society for Testing and Materials (ASTM) Standards	
ASTM D1784	Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2321	Recommended practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	Polyvinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F1417	Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
American Water Works Association (AWWA) Standard	
AWWA M23	PVC Pipe – Design and Installation
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C153	Ductile-Iron Compact Fittings

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 – Contractor Submittals.

B. Certificates: The Contractor shall submit manufacturer's certificate that pipe conforms to the Contract Documents.

1.4 QUALITY ASSURANCE

A. Testing: Materials testing shall be based upon applicable ASTM Test Methods referenced herein.

B. Costs of such inspection and tests shall be borne by the Contractor as part of the Work.

C. Mandrel Test: In addition to the requirements as specified in Section 01 74 20- Gravity Pipeline Testing, all PVC gravity sewer pipe shall be tested for deflection and obstructions. The mandrel test shall be performed after backfilling and compacting but prior to final paving and prior to leakage testing. A rigid mandrel with a circular cross section having a diameter of at least 95 percent of the average inside diameter shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe. If the mandrel sticks in the pipe at any point the pipe shall be repaired and retested.

D. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.

E. The pipe shall be subjected to the specified flattening resistance, impact resistance, and stiffness tests.

1.5 CLEANUP

A. In addition to the requirements of Section 01 77 00 - Project Closeout, the Contractor, upon completion of backfilling and grading over trenches, shall remove excess materials and equipment from the Site.

PART 2 -- PRODUCTS

2.1 GENERAL

A. PVC Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi as required in ASTM D3034 or ASTM F679.

B. Manufacturing records: Contractor shall ensure in writing that the manufacturer maintains their manufacturing records for a minimum of 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

A. Pipe shall conform to the requirements of ASTM D 3034 (4-in to 15-in) or ASTM F679 (18-in to 60-in). Material for pipe shall conform to the requirements of ASTM D1784.

B. The manufacturer shall test a sample from each batch according to ASTM D2444.

C. Joints shall be gasketed push-on type conforming to ASTM D3212. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F477 or ASTM F913. Joint lubricant shall be approved by the Pipe Manufacturer and shall have no detrimental effect on the gasket or pipe.

2.3 FITTINGS

A. Fittings shall conform to the requirements of ASTM D3034 or ASTM F679. The ring groove and gasket ring shall be compatible with PVC pipe ends. Flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

C. Fittings may also be supplied as ductile iron fittings in accordance with AWWA C110 and/or AWWA C153.

2.4 BEDDING MATERIAL

A. Unless otherwise indicated, material used for pipe bedding shall conform to Section 31 30 00 – Earthwork.

2.5 FLEXIBLE COUPLINGS

A. Flexible couplings less than 24-in diameter shall be neoprene, full-circle, clamp-on type conforming to ASTM D5926 and shall be provided with 2 stainless steel band screw-clamps to secure the coupling tightly to entering and exiting pipes. Screw-clamp hardware shall be Type 304 or Type 316 stainless steel. Neoprene material shall be suitable for sewage service.

PART 3 -- EXECUTION

3.1 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 - Earthwork

B. The minimum depth of cover over the top of the pipe shall be 36-in unless otherwise indicated.

3.2 LAYING PIPE

A. Pipe shall be installed in accordance with the requirements of ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications and as indicated. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.

B. Handling

1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to ensure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.

2. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.

C. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

D. Foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. Openings in the pipeline shall be closed with watertight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

E. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work shall be the Contractor's responsibility.

F. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the Contractor's responsibility.

3.3 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. Fittings shall be carefully connected to pipe, and joint shall be checked to ensure a sound and proper joint.

E. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe that has floated shall be removed from the trench, cleaned, and re-laid in an acceptable manner. No pipe shall be laid when, in the opinion of the Engineer, the trench conditions or weather are unsuitable.

3.4 TESTING

A. The internal diameter of the pipe barrel shall not be reduced by more than 5 percent of its base diameter when measured after backfilling and compacting but prior to final paving and prior to leakage testing. If this amount of allowable pipe deflection is exceeded, the Contractor shall uncover the pipe and shall improve the quality of the pipe zone backfill material and/or compaction to the extent that the allowable pipe deflection is not exceeded. Excessive deflection shall be checked for by pulling a mandrel through the pipe, or by other methods acceptable to the Engineer.

B. Field testing of gravity sewer pipe shall conform to the requirements of Section 01 74 20 - Gravity Pipeline Testing.

END OF SECTION

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SECTION 33 16 00 - FIBERGLASS REINFORCED PLASTIC STORAGE TANKS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide fiber glass reinforced plastic tanks, and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The WORK under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.

C. Plastic and fiber glass items shall be manufactured of material suitable for potable water or the chemicals they contact, and shall be certified for such use on the Shop Drawings. Tanks shall be designed and checked for loads to be incurred during service, including at least wind, temperature stress, and seismic loads by a registered engineer with a minimum of 5 years experience in fiber glass construction. Seismic loads shall be in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Codes

NFPA 70	National Electric Code

B. Commercial Standards

ASTM C 581	Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service
ASTM D 638	Test Method for Tensile Properties of Plastics
ASTM D 695	Test Method for Compressive Properties of Rigid Plastics
ASTM D 790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 883	Definitions of Terms Relating to Plastics
ASTM D 2563	Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D 2583	Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
ASTM D 3299	Filament-Wound Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
ASTM D 4097	Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks

C. When 2 or more of the above regulations are applicable, the more stringent requirement shall be met.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Include detailed and certified design calculations by a registered engineer, bill of materials listing components, resins, catalysts, promoters, ultraviolet light absorbers, agents, reinforcing materials, etc., with manufacturer's name, trade and identification marks. The laminate sequence used for tanks must either be attached to or included on drawings used by the fabricator's shop personnel.

1. Dimensions including anchor bolt layouts.

2. Details of clips and lugs for ladders, stairs, platforms, hold down lugs, pipe brackets, and anchor bolts as integral parts of the tank. Pipe supports shall be spaced maximum 5-feet on centers.

3. Details of structural support members.

4. Equipment capacity, gallons.

5. Maximum design specific gravity.

6. Equipment weight, empty and filled with water.

7. Laminate sequence of construction and materials of construction.

8. Specifications for supplied bolting, gaskets, and accessory items.

PART 2 -- PRODUCTS

2.1 TANK DESIGN

A. Standards: Construction of tanks shall be in accordance with ASTM standards listed herein.

B. Fiber glass tanks shall be constructed using the filament winding or contact molded method. Flanged nozzles shall be conically-gussetted with minimum strength requirements of 1500 ft lb of bending and 200 ft lb of torque and suitable for connection to PVC pipe. Unless otherwise indicated, 40-50 durometer 1/8-inch thick full face gaskets shall be used.

C. Tank Design - Fiberglass reinforced plastic (FRP) tanks:

1. The tank size, fittings and accessories shall be as shown on the drawings.

2. Tank shall be manufactured with structural ribs which are fabricated as an integral part of the tank wall.

3. Tank shall be manufactured with a laminate consisting of resin and glass fiber reinforcement only. No sand/silica fillers or resin extenders shall be used.

4. Tank shall be vented to atmospheric pressure.

5. Tank shall be capable of handling liquids with specific gravity up to 1.1.

D. Loading Conditions - Tank shall meet the following design criteria:

1. Internal Load: Tank shall be designed to withstand a 5-psig (35 kPa) air-pressure test with a 5:1 safety factor.

2. Surface Load: Tank shall be designed to withstand surface H-20 and HS-20 axle loads when properly installed according to manufacturer's current Installation Manual and Operating Guidelines.

3. External Hydrostatic Pressure for Underground Water Tank shall be designed for 7 feet (2.1 m) of overburden over the top of the tank, the hole fully flooded, and a safety factor of 5:1 against general buckling.

E. Tank Design: Double-Wall vessel as specified and shown on the Drawings.

1. Interstitial Space

a. The interstitial space between the primary and secondary walls shall be constructed with a glass reinforcement material such as Parabeam®, which provides a structural bond between the two tank walls while creating a defined interstice that allows for free flow of liquid.

b. A tank top fitting shall be provided to allow for a monitoring sensor to be installed at the bottom of the interstice.

c. The interstice of the tank shall be designed to withstand 20-psig (138 kPa) pressure.

F. Tank Accessories

1. Tank Anchoring:

a. Anchor straps shall be as supplied by tank manufacturer and designed for a maximum load of 25,000 lbs (11340 kg).

b. Galvanized turnbuckles shall be supplied by the tank manufacturer.

c. Prefabricated concrete anchors shall be supplied by the tank manufacturer, designed to the ACI 318 standard, manufactured with 4,000 psi concrete and shall have adjustable anchor points

2. Manway Openings:

a. Manways on storage tanks and equipment shall be 24-inches ID. Access openings on tops of mixing tanks may be removable sections but shall be bolted

down Manway openings shall be designed to withstand 5-psig (35 kPa) test pressure with a 5:1 safety factor.

b. Manway extensions shall be FRP and shall be supplied by tank manufacturer.

3. Piping and Fittings:

a. Tank shall be equipped with internal factory-installed piping that meets NSF/ANSI Standard 61.

b. All flanged nozzles shall be flanged and flat-faced and conform to Class 150 bolting patterns as specified in ANSI/ASME/ B16.5.

c. Flanges shall be made by hand lay-up. Flanges shall be flat and true to a tolerance of plus or minus 1/32-inch.

d. Flange drilling on pipe connections shall be in accordance with ANSI B-16.5 for 150 psi pressure class. Minimum flange thickness shall be based on 50 psi pressure rating.

e. Carbon steel and stainless steel NPT fittings shall withstand a minimum of 150 foot-pounds (203 NM) of torque and 1,000 foot-pounds (1356 NM) of bending, both with a 2:1 safety factor.

4. Pump Platforms:

a. Pump platforms shall be the pump platform listed under NSF/ANSI Standard 61 as supplied by tank manufacturer.

G. Fiber Glass Tank Schedule: The following fiber glass tanks are included:

I.D. No.	Location	Service	Size, in	Volume, gal
T-540	Incubation Building	Formalin Metering	96	11,000

H. Seismic: Tanks shall be designed to resist stresses created by a seismic event represented by the following design spectral response accelerations when the tank is full of a 1.08 specific gravity liquid in accordance with section 01 33 17 - Structural Design, Support and Anchorage.

1. Design Spectral Response Acceleration at period of 1s, S_{D1} = 0.536

2. Design Spectral Response Acceleration at short periods, S_{DS} = 0.818

2.2 MATERIALS OF CONSTRUCTION

A. Resin: Resin shall be **Derakane 411**, **Atlac 382**, or equal. To allow verification that fresh resin is used, manufacturer lot numbers of the resin used shall be shipped with the completed tank. No sand/silica fillers or resin extenders shall be used.

2.3 CONSTRUCTION

A. General: Tanks that can be constructed with a continuous shell shall be fabricated using the filament winding technique. Those tanks that must be built in sections, shall be constructed using the contact molded or filament wound technique. Tanks too small to filament wind may also be fabricated using contact molded techniques.

B. Laminate Construction: Laminate construction shall be as follows:

1. Chemical-Resistant Barrier: Tanks, whether they are constructed using the filament winding or contact molded process, shall consist of an inner surface and an interior layer which constitutes the chemical-resistant barrier, and an exterior or structural layer. The inner surface shall be free from cracks and crazing, with a smooth finish. The resin-rich surface shall be between 0.010- and 0.020-inch thick and be reinforced with C-glass. The resin to glass ratio should be approximately 90 percent resin and 10 percent glass. The interior layer shall consist of either (1) 3 layers of 1-1/2 oz/sq ft E-glass chopped strand mat, or (2) 2 layers of 1-1/2 oz/sq ft E-glass chopped strand mat followed by one pass by the spray-up process. In no case shall the combined thickness of the inner surface and the interior layer be less than 0.100-inch. The glass content for the interior layer shall be 20 to 30 percent.

2. Contact Molded Laminates: The contact molded process includes fabrication by the hand lay-up, contact pressure molding, and spray processes or combinations thereof, according to ASTM D 4097, except as otherwise noted. In addition, inner surface and interior layer shall be constructed as required in the preceding paragraph. The exterior layer or body of the laminate shall provide the additional strength necessary to meet the tensile and flexural requirements.

3. Outer Surface: When air-inhibited resins are cured with an air-exposed surface, a wax-containing resin coating, formulated according to the resin manufacturer's most recent recommendations, shall be used.

2.4 WORKMANSHIP

A. Visual Defects: ASTM D 2563 shall be used for quality control of both filament-wound and hand lay-up construction. Acceptance levels shall be as follows:

Process Surface	Defects
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Entrapped Air	None at surface. If in laminate, 1/16-in dia max and 5/sq in max.

Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits	Max 1/8-in dia by 1/32-in deep, max 10/sq ft.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 10 percent of wall thickness
Sharp Discontinuity	None

Non-Process Surface	Defects
Blisters	Max 1/4-in dia 1/16-in high
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq in/sq ft
Entrapped Air	1/8-in dia max; no more than 3 percent of area
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate
Pits	Max 1/8-in dia by 1/16-in deep
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in
Sharp Discontinuity	None

B. If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas shall be repaired and reinspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.

2.5 BOLTS, ANCHOR BOLTS, WASHERS, SUPPORTS, AND HOLD DOWN LUGS

A. The CONTRACTOR shall provide bolts, anchor bolts, nuts, washers, and supports as required for the plastic and fiber glass items in this Section and in accordance with the requirements of the manufacturers of the plastic and fiber glass items. Bolts, anchor bolts, washers, hold down lugs, and supports required in connection with the plastic or fiber glass items shall be of Type 316 stainless steel.

2.6 MANUFACTURERS, OR EQUAL

A. **Xerxes Corporation**

B. **Beetle Plastics**

C. **Pacific Tank Ltd**.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Fiber glass reinforced plastic tanks shall be installed as per manufacturer's instructions. Pipes and equipment connecting to the tanks shall be firmly supported to avoid stresses on the tank.

3.2 TESTING

A. Tank shall be tested according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

END OF SECTION

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SECTION 33 40 00 – STORMWATER UTILITIES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide storm drain piping, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Contractor Submittals
03 30 00	Cast-in-Place Concrete
31 30 00	Earthwork
33 05 16	Precast Concrete Manholes and Vaults
33 92 20	Ductile Iron Piping
33 05 31.11	PVC Drainage Pipe

B. Reference Standards

American Society for Testing and Materials (ASTM) Standards	
ASTM C478	Circular Precast Reinforced Concrete Manhole Sections
ASTM D1784	Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM F679	Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
American Water Works Association (AWWA) Standard	
C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C151	Standard for Ductile Iron Pipe, Centrifugally Cast
American Association of State Highway and Transportation Officials (AASHTO) Standard	
M36	Corrugated Steel Pipe, Metallic Coated, for Sewers and Drains
M196	Corrugated Aluminum Pipe for Sewers and Drains

1.3 SUBMITTALS

A. Shop Drawings and catalog data submittals shall be made in accordance with Section 01 33 00– Contractor Submittals.

B. Provide manufacturer's product information, shop drawings, and O&M information for storm drainage materials including:

1. Pipe

2. Fittings

3. Pre-Cast and Cast-in-Place Structures

4. Outfalls

5. Castings

6. Inlets

C. A manufacturer's or fabricator's Certificate of Compliance shall be furnished stating that samples representing each lot have been tested and inspected in accordance with the Contract Documents and have been found to meet the requirements for the material described.

1.4 CLEARING

A. Clearing for installation of pipe and drainage structures shall be confined within the working limits of the trenches. Trees, utility poles, survey monuments, and underground and overhead utilities shall be suitably protected and preserved.

1.5 EXISTING UTILITIES

A. Contractor shall furnish temporary support, adequate protection, and maintenance of underground and surface utility structures, drains, sewers, cables, etc., and other obstructions encountered in the progress of the Work.

B. When the grade of alignment of the pipe is obstructed by existing utility structures, such as conduits, ducts, pipes, branch connections to water or sewer mains, and other obstructions, the obstructions shall be permanently supported, relocated, removed or reconstructed by the Contractor in cooperation with the owners of such structures. No deviation shall be made from the required line or grade except as accepted in writing by the Engineer.

C. It shall be the responsibility of the Contractor to notify the owners of existing utilities in the area of construction a minimum of 48 hours prior to any excavation adjacent of such utilities, so that field locations of said utilities may be established.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage

1. Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

B. Handling

1. Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall not be rolled or dragged over gravel or rock, and during placement, shall be prevented from striking rock or other hard objects. Special care shall be taken in handling and placing coated pipe to avoid damaging any coating.

PART 2 -- PRODUCTS

2.1 PIPE

A. DUCTILE IRON (DI) PIPE

1. Refer to Section 33 92 20 – Ductile-Iron Piping

2. Ductile iron pipe shall conform to AWWA C151, C104, and C105 subject to the supplemental requirements in Section 33 92 20 – Ductile-Iron Piping. The pipe shall be of the diameter and class indicated, shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

B. POLYVINYL CHLORIDE (PVC) SEWER PIPE

1. Refer to Section 33 05 31.11 – Polyvinyl Chloride Gravity Sewer Pipe.

2. Pipe shall conform to the requirements of ASTM D3034 4-in to 15-in or ASTM F679 18-in to 60-in. Material for pipe shall conform to the requirements of ASTM D1784.

C. CORRUGATED METAL PIPE (CMP)

1. Corrugated metal pipe shall include round pipe, pipe arch, and underdrain pipe, both corrugated steel and corrugated aluminum, coated and uncoated, with or without a paved invert, and including fittings, couplings, and related accessories.

2. Corrugated steel pipe, pipe arch, and underdrain and coupling bands and fittings for each type, shall conform to the requirements of AASHTO M-36.

3. Corrugated aluminum pipe, pipe arch, underdrain and coupling bands and fittings for each type, shall conform to the requirements of AASHTO M-196.

2.2 STORM DRAINAGE STRUCTURES

A. Precast Concrete Manholes and Vaults

1. Refer to Section 33 05 16– Precast Concrete Manholes and Vaults

2. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C 478, and the requirements of this Section. Minimum wall thickness of rings shall be 4-in if steel reinforced and 6-in if not reinforced.

3. Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

4. The minimum structural member thickness for vaults shall be 5-in Cement shall be Type V Portland cement as specified in ASTM C 150. The minimum 28-day concrete compressive strength shall be 4,000 psi.

B. Cast-in-Place Manholes and Vaults

1. Refer to Section 03 30 00 – Cast-in-Place Concrete

2. Contractor shall provide cast-in-place vaults designed for the indicated applications and of the sizes indicated.

2.3 INLETS

A. Area Drains and Inlets

1. Contractor shall provide area drains and inlets designed for the indicated applications and of the sizes indicated.

B. Curbside Drains and Inlets

1. Contractor shall provide curbside drains and inlets designed for the indicated applications and of the sizes indicated.

C. Trench Drains

1. Contractor shall provide trench drains designed for the indicated applications and of the sizes indicated.

PART 3 -- EXECUTION

3.1 EXCAVATIONS

A. Trench walls shall be compliant with local Occupational Health and Safety regulations and as vertical as practical given regulatory constraints. and , if required, trench walls shall be properly sheeted and braced. Where, in the opinion of the Engineer, damage could result from withdrawing sheeting, the sheeting shall be left in place. Not more than 100 ft of trench shall be opened at any one time or in advance of pipe laying unless permitted by the Engineer.

1. Except in rock, water-bearing earth, or where a granular or concrete base is to be used, mechanical excavation of trenches shall be stopped above the final grade elevation so that the pipe may be laid on a firm, undisturbed native earth bed. If over-digging occurs, loosened earth shall be removed, and the trench bottom brought back to grade with granular material.

2. Excavations and trenches in rock shall be carried to a depth of not less than below the pipe bottom. This space shall be filled with granular material or washed rock.

3. Width of trenches shall be such as to provide adequate space for placing and jointing pipe properly, but in every case the trench shall be kept to a minimum width.

4. Unstable soil shall be removed and replaced with gravel, crushed rock, or rock and sand suitably compacted.

3.2 PREPARATION OF TRENCH BOTTOM

A. Water shall not be allowed in the trenches while the trench bottom is being prepared or while pipe is being installed, unless accepted by the Engineer.

B. A continuous trough shall be shaped a minimum of 8-in below the bottom of the pipe to receive the bottom quadrant of the pipe barrel. Bell holes shall be excavated so that after placement, only the barrel of the pipe receives bearing pressure from the trench bottom.

3.3 INSTALLATION OF DRAINAGE PIPE

A. Pipe shall be protected during handling against impact shocks and free falls. Pipe shall be kept clean, and no pipe shall be used that does not conform to the Specifications.

B. The laying of the pipe shall be commenced at the lowest point with spigot ends pointing in the direction of flow. Pipe shall be laid with ends abutting and true to line and grade and in accordance with manufacturer's requirements.

C. Pipe shall be laid accurately to the line and grade required. Preparatory to making pipe joints, surfaces of the portions of the pipe to be jointed or of the factory-made jointing material shall be clean and dry. Lubricant, primers, adhesive, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing materials or factory-fabricated joints shall then be placed, fitted, joined, and adjusted in such a manner as to obtain a watertight line. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of pipe.

D. The exposed ends of pipe shall be suitably plugged to prevent earth, water, or other substances from entering the pipe when construction is not in progress.

3.4 BACKFILLING TRENCHES

A. Pipe trench backfill shall be in accordance with the requirements of Section 31 30 00 – Earthwork Methods.

B. Whenever the trenches have been improperly filled or if settlement occurs, they shall be refilled, compacted, smoothed off, and made to conform to grade. Unless otherwise directed, backfill in trenches in or through roadways shall be made as indicated, except that the entire fill above one-foot over the pipe shall be deposited in layers not to exceed 8-in 200mm in thickness, moistened, and compacted to density equal to or greater than that of adjacent material so that pavement can be placed immediately.

3.5 RESTORATION OF SURFACES AND/OR STRUCTURES

A. The Contractor shall restore and/or replace paving, curbing, sidewalks, fences, and survey points, or any other disturbed surfaces or structures to a condition equal to that before the Work was begun and to the satisfaction of the Engineer. The Contractor shall comply with requirements of governing agencies including town, city, and state for restoration of surfaces and/or structures.

END OF SECTION

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SECTION 33 92 20 - DUCTILE IRON PIPE AND FITTINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide ductile iron pipe and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in for Water
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast for Water
AWWA C153	Ductile-Iron Compact Fittings. for Water Service
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
ASTM C 150	Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. Furnish Submittals in accordance with Section 01 33 00 - Contractor Submittals and the following supplemental requirements:

B. Shop Drawings

1. Certified dimensional drawings of valves, fittings, and appurtenances.

C. Certifications: Certified affidavit of compliance for pipe and other products or materials furnished under this Section and as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.

2. Hydrostatic test reports.

D. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY ASSURANCE

A. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

B. The CONTRACTOR shall perform said material tests as part of the WORK. The ENGINEER shall have the right to witness testing conducted by the CONTRACTOR; provided, that the CONTRACTOR's schedule is not delayed for the convenience of the ENGINEER.

C. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including lining and coating samples for testing by the OWNER. The additional samples shall be furnished as a part of the WORK.

D. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 Days prior to the start of any phase of the pipe manufacture.

E. During the manufacture of the pipe, the ENGINEER shall be given access to areas where manufacturing is in process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

PART 2 -- PRODUCTS

2.1 PIPE GENERAL

A. Mortar-lined ductile iron pipe shall conform to AWWA C151, C104, and C105, subject to the supplemental requirements in this Section. The pipe shall be of the diameter and class indicated, shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

B. Markings: The CONTRACTOR shall legibly mark specials 24-inches diameter and larger in accordance with the laying schedule and marking diagram. Each fitting shall be marked at each end with top field centerline.

C. Handling and Storage: The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on padded skids, sand or earth berms free of rock exceeding 3-inches diameter, sand bags, or suitable means so that the coating will not be damaged. The pipe shall not be rolled and shall be secured to prevent accidental rolling

D. Laying Lengths: Nominal pipe laying lengths shall be 20-feet.

E. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

F. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing on the Drawings. The locations of correction pieces and closure assemblies are indicated. Any change in location or number of said items shall only be as accepted by the ENGINEER.

2.2 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of AWWA C153 or AWWA C110 and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inches shall conform to AWWA C153.

2.3 DESIGN OF PIPE

A. The pipe shall be designed, manufactured, tested, inspected, and marked according to AWWA C150 and C151 except where modified by this Section.

B. Pipe Dimensions: The pipe shall be of the diameter and minimum Class 50.

C. Fitting Dimensions: The fittings shall be Class 50 and of the diameter indicated.

D. Joint Design: Ductile iron pipe and fittings for buried pressure service shall be furnished with restrained joints, unless otherwise indicated. Ductile iron pipe and fittings for buried gravity service shall be furnished with mechanical joints unless otherwise indicated. Above ground ductile iron pipe and fittings joints shall be as indicated. Flanged shall be furnished where required.

1. Mechanical and push-on joints shall conform to AWWA C111.

2. Flanged joints shall conform to AWWA C115. Where threaded flanges are provided, the pipe wall thickness under the cut threads shall not be less than the calculated net thickness required for the pressure class of the pipe.

3. Restrained joints at pipe-to-pipe locations shall be **Flex-Ring or Lok-Ring** restrained joint by **American Ductile Iron Pipe**, **TR FLEX** restrained joint by **U.S. Pipe**, or equal.

4. Restrained joints at pipe-to-fitting locations shall be **MegaLug Model 1100** as manufactured by **EBAA Iron** or equal.

E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.4 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by

suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

1. Cement: Cement for mortar lining shall conform to the requirements of AWWA C104; provided, that cement for mortar lining shall be Type II or V. Cement shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter, inches	Minimum Lining Thickness, inches
3 - 12	1/16
14 - 24	3/32

C. Protection of Pipe Lining/Interior**:** Shop-applied cement mortar lining shall be given a seal coat of asphaltic material in conformance with AWWA C104.

2.5 EXTERIOR PROTECTION OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned, given a shop coat of rust-inhibitive primer, and finish coated conforming to the requirements of Section 09 96 00 - Protective Coating.

B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately 1-mil thick.

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. The CONTRACTOR shall inspect each pipe and fitting prior to installation to insure that there are no damaged portions of the pipe. Pipe damaged prior to Substantial Completion shall be repaired or replaced by the CONTRACTOR.

B. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of pipes and fittings in the trench shall be closed during any interruption to the WORK.

C. Pipe Laying: The pipe shall be installed in accordance with AWWA C600.

D. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after

the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Each section of pipe 24-inches diameter and larger shall be laid in the order and position shown on the laying schedule. Each section shall be laid to the line and grade, within approximately one-inch plus or minus.

F. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the ENGINEER may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

G. Except for short runs that may be permitted by the ENGINEER, pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be properly installed as indicated.

H. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.

I. Pipe and Specials Protection: The openings of pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

J. Pipe Cleanup: As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of debris. The CONTRACTOR shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying and shall perform any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.2 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket shall be placed in the bell groove. The spigot end of the pipe and the inside surface of the gasket shall be carefully cleaned and lubricated. The lubricant shall be suitable for lubricating the parts of the joint for assembly and be a compound listed as in compliance with NSF Standard 61. The lubricant shall be nontoxic, shall not support the growth of bacteria, and shall have no deleterious effects on the gasket material. The lubricant shall not impart taste or odor to water in the pipe. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.3 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is dielectric-coated, buried appurtenances shall be coated in kind. Where pipe is encased in polyethylene sleeves, buried appurtenances shall be encased in polyethylene.

B. Installation of Valves: Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The CONTRACTOR shall adjust stem packing and operate each valve prior to installation to insure proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

END OF SECTION

SECTION 33 95 34 – LARGE POLYETHYLENE PRESSURE PIPING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide high density polyethylene (HDPE) pressure pipe, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4-In Through 63-In, for Water Distribution and Transmission
ASTM D 3350	Polyethylene Plastics Pipe and Fittings Materials

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings of pipe, fittings, and appurtenances in accordance with Section 01 33 00 - Contractor Submittals.

B. Certifications: Furnish a certified affidavit of compliance for pipe and other products or materials furnished under this Section:

1. Hydrostatic proof test reports.

2. Sustained pressure test reports.

3. Burst strength test reports.

C. Expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR as part of the WORK.

1.4 QUALITY ASSURANCE

A. Each manufacturer shall have an approved in-house QA/QC program for compliance to the testing specifications and requirements of AWWA C906 for both pipe and fittings.

B. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing start date not less than 14 calendar days prior to the start of any phase of manufacture.

C. During manufacture of the pipe, the ENGINEER shall be given access to areas where manufacturing is in process confirm compliance with the Specifications.

D. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section and in the referenced standards, as applicable.

E. The CONTRACTOR shall perform said material tests in accordance with the requirements of the Contract Documents. The ENGINEER shall have the right to witness testing

conducted by the CONTRACTOR, provided that the CONTRACTOR's schedule will not be delayed for the convenience of the ENGINEER.

F. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished as part of the WORK.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Scope: The pipe shall be 42-, 36-, 30-, 24-, 20-, or 12- inch nominal, as indicated in the plans, meeting the specifications and requirements of AWWA C 906. Pipe shall be in steel pipe sizes (IPS). Pipe shall be in ductile iron pipe sizes (DIPS).

B. Materials: Pipe and fittings shall be made from prime virgin resins exhibiting a cell classification of PE 345444C as defined in ASTM D 3350, with an established hydrostatic-design basis of 1600 psi for water at 73 degrees F. The resin shall be listed by the PPI (Plastic Pipe Institute) in its pipe-grade registry Technical Report (TR) 4, "Listing of Plastic Pipe Compounds.

C. Pipe and Fittings: The pressure rating shall be at least DR 32.5. Laying lengths shall be 20-ft standard. Both pipe and fittings shall be listed as compliant with NSF Standard 61 and shall bear the "NSF-pw" logo or mark.

D. Joints: Pipe sections shall be joined by heat fusion.

E. Marking: Pipe and fittings shall be marked as prescribed by AWWA C906. Pipe markings shall include nominal size, OD base (ie: 12-inch ductile iron pipe sizing, DIPS), dimension ratio, pressure class, AWWA C906, manufacturer's name, manufacturer's production code including day, month, and year extruded, manufacturer's plant and extrusion line, and the “NSF-pw” logo.

2.2 PLASTIC MARKING TAPE

A. The pipeline shall be marked with a magnetically detectable marking tape. The tape shall be placed along the trench centerline between 18- and 24-inches above the pipe.

PART 3 -- EXECUTION

3.1 GENERAL

A. Laying, jointing, and testing for defects and for leakage shall be performed in the presence of the ENGINEER and shall be subject to approval before acceptance. All material found to be defective will be rejected and the CONTRACTOR shall promptly remove such materials from the Site.

B. Installation shall conform to AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. Handling: Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective will be rejected. Pipe and fittings shall be free from fins and burrs. Before placing in position, clean pipe, fittings, and accessories, and maintain them in a clean condition. Proper methods shall be used for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.

B. Storage: Pipe shall be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to the pipe. Pipe shall be stored in such a way as to prevent sagging or bending, and it shall be protected from exposure to direct sunlight by covering with an opaque material that allows adequate air circulation above and around the pipe. Gaskets shall be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to Section 31 30 00 - Earthwork.

3.4 JOINING

A. Prior to installation of any pipe, the manufacturer shall provide training in the recommended butt fusion and saddle fusion procedures, testing procedures, and any other installation methods required by the WORK. Training shall include the CONTRACTOR's installation personnel, an OWNER's representative, the ENGINEER's representative, and any other personnel chosen by the OWNER. The CONTRACTOR shall record the names of trained personnel.

B. On every day that butt fusion joints are to be made, the first fusion of the day shall be a test. The test fusion shall be allowed to cool completely, then fusion test straps shall be cut out. Test strap length shall be 12-inches (min) or 30 times the wall thickness with the fused area in the center and width shall be 1-inch (min) or 1.5 times the wall thickness. The CONTRACTOR shall bend the test strap until the ends of the strap touch. If the test strap fails at the joint, the CONTRACTOR shall perform a new test to be cooled completely and bent as before. The CONTRACTOR shall not commence installation of pipe until a test fusion has passed the bent strap test.

3.5 INSTALLATION

A. Trench shall be graded in straight or curved lines matching the proposed alignments, taking care to avoid formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be cut by means of saws, power driven abrasive wheels, pipe cutters, or other manufacturer recommended methods that will produce a clean, square cut.

C. Pipe shall be supported uniformly and firmly at its proper elevation. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the soil, with recesses to accommodate joints and couplings. Anchors and supports shall be provided where necessary and where indicated for fastening WORK into place. Fittings shall be independently supported.

D. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing shall be replaced.

E. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

3.6 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01 74 30 - Pressure Pipe Testing.

END OF SECTION

SECTION 33 95 40 - SMALL POLY VINYL CHLORIDE NON-PRESSURE PIPING, RUBBER JOINTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide PVC solid wall nonpressure pipe and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

B. This Section covers pipe from 4 to 15-inches diameter nominal size.

1.2 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: The CONTRACTOR shall submit Shop Drawings and laying diagrams of pipe, joints, bends, special fittings, and piping appurtenances.

C. Certificates: The CONTRACTOR shall submit manufacturer's certificate that pipe conforms to these specifications.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi.

B. The CONTRACTOR shall also require the manufacturer to mark the date of extrusion on the pipe. This dating shall be done in conjunction with records to be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

A. Pipe shall conform to the requirements of ASTM D 3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR 35. Material for PVC pipe shall conform to the requirements of ASTM D 1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, for cell classification 12454-B or 12454-C as defined therein. The manufacturer shall test a sample from each batch according to ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

B. Joints shall conform to ASTM D 3212 - Joints for Drain and Sewer Plastic Pipe Using Flexible Elastomeric Seals. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F 477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe or ASTM F 913 - Thermoplastic Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

2.3 FITTINGS

A. Fittings shall conform to the requirements of ASTM D 3034. The ring groove and gasket ring shall be compatible with PVC pipe ends. The flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

2.4 BEDDING MATERIAL

A. Unless otherwise indicated, material used for pipe bedding shall conform to Section 31 30 00 - Earthwork.

2.5 FLEXIBLE COUPLINGS

A. Flexible couplings shall be neoprene, full-circle, clamp-on type conforming to ASTM C 425 - Compression Joints for Vitrified Clay Pipe and Fittings and provided with 2 stainless steel band screw-clamps to secure the coupling tightly to entering and exiting pipes. Screw-clamp hardware shall be Type 304 or Type 316 stainless steel. Neoprene material shall be suitable for sewage service.

PART 3 -- EXECUTION

3.1 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 - Earthwork and the Drawings.

3.2 LAYING PIPE

A. Pipe shall be installed in accordance with the requirements of ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications and as indicated. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.

B. Handling

1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to insure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.

2. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.

C. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard

iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

D. Foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. Openings in the pipeline shall be closed with watertight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

E. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the WORK shall be the CONTRACTOR's responsibility.

F. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the CONTRACTOR in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the CONTRACTOR's responsibility.

3.3 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. Fittings shall be carefully connected to pipe, and joint shall be checked to insure a sound and proper joint.

E. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe that has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the ENGINEER, the trench conditions or weather are unsuitable.

3.4 TESTING

A. Field testing of gravity pipe shall conform to the requirements of Section 01 74 20 - Gravity Pipeline Testing.

END OF SECTION

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SECTION 33 95 46 – PVC DRAINAGE PIPE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide polyvinyl chloride (PVC) drainage pipe, complete in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

1. ASTM D1784 Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds

2. ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

3. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe1

4. ASTM F794 Standard Specification for PVC Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

5. ASTM F949 Standard Specification for PVC Corrugated Sewer Pipe with a Smooth Interior and Fittings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. **Shop Drawings**: Drawings of pipe, fittings, and appurtenances.

C. **Catalog Cut Sheets**: Catalog cut sheets demonstrating compliance of pipe and other products and materials with the requirements specified herein.

D. The CONTRACTOR shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY ASSURANCE

A. **Inspection:** Pipe shall be subject to inspection at the place of manufacture. The CONTRACTOR shall notify the ENGINEER in writing of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. During manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in process and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.

C. **Tests:** Materials used in manufacture of the pipe shall be tested in accordance with the requirements of this Section and the referenced standards, as applicable.

D. The CONTRACTOR shall perform said material tests. The ENGINEER shall have the right to witness testing; provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.

E. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the OWNER. The additional samples shall be furnished as a part of the WORK.

PART 2 -- PRODUCTS

2.1 GENERAL

A. PVC drainage pipe (4-inch through 36-inch) shall conform to the applicable requirements of ASTM F794 and F949, subject to additional requirements herein. Where these requirements are in conflict, the more stringent requirement shall apply.

B. PVC drainage pipe shall be manufactured of poly vinyl chloride (PVC) meeting cell class 12454 per ASTM D 1784.

2.2 PIPE DESIGN CRITERIA

A. **General:** PVC drainage pipe shall be designed in accordance with the requirements of ASTM F794 and F949, as applicable, and the supplemental requirements in this Section.

B. **Pipe Stiffness:** PVC drainage pipe and fittings shall have a minimum pipe stiffness of 46 psi at 5% deflection, except where increased stiffness is indicated. Where indicated, pipe and fittings with a minimum stiffness of 115 psi at 5% deflection shall be provided.

C. **Interior Wall Smoothness:** PVC drainage pipe shall have a Manning's "n" 0.009.

2.3 PIPE

A. The pipe shall be dual-wall, corrugated type, of the nominal diameter indicated. The pipe shall be furnished complete with rubber gaskets, and all specials and fittings shall be provided as required in the Contract Documents. The dimensions shall conform to the requirements of ASTM F794 and ASTM F949.

B. **Joints:** Joints for the buried PVC pipe shall be an integral bell and spigot in accordance with ASTM F949. Joint tightness shall meet or exceed the requirements of ASTM D 3212.

C. **Joint Deflection:** Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints that are over-belled or not belled to the stop mark.

D. **Gaskets:** Gaskets shall meet the requirements of ASTM F477.

2.4 FITTINGS

A. Fittings shall conform to the requirements of ASTM F794 and ASTM F949.

B. Metal fittings shall be lined and coated in accordance with the requirements of Section 09 96 00 - Protective Coating.

C. Each fitting shall be clearly labeled to identify its size and stiffness class.

D. Fittings shall be smooth inside and free from any obstructions to flow.

E. Caps: Provide caps at open ends of pipe. Provide caps which permanently prevent intrusion of soil into the pipe. Provide caps per manufacturer's recommendations.

F. Pipe and Fittings shall be provided by the same manufacturer.

2.5 MANUFACTURERS, OR EQUAL:

A. Contech Construction Products, Inc.

PART 3 -- EXECUTION

3.1 GENERAL

A. Laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to approval before acceptance. Material found to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the Site.

B. Welded fittings shall be free from internal flow obstructions, including but not limited to beading from welds. All pipe and fittings found to have any internal obstruction to flow shall be rejected by the CONTRACTOR upon delivery to the site.

C. Installation shall conform to the requirements of ASTM F794 and ASTM F949, instructions furnished by the pipe manufacturer, and to the supplementary requirements herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

D. No vehicular traffic of any kind shall be parked, driven, loaded, unloaded, or in any way located on top of PVC drainage pipe without a minimum nominal continuous cover of 10" of rock or soil above the top of the pipe. Under any and all circumstances and regardless of depth of cover, vehicles that exceed the specified maximum loaded vehicle weight allowed on the reservoir roof shall not be located above PVC drainage pipe.

3.2 HANDLING AND STORAGE

A. Handling: Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

B. Storage: Pipe should be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe should be stored in such a way as to prevent sagging or bending and be protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets should be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 - Earthwork.

3.4 INSTALLATION

A. Bell-and-spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be graded in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be supported at its proper elevation and grade; care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells, joints, and couplings. Anchors and supports shall be provided where indicated and where necessary for fastening work into place. Fittings shall be independently supported.

C. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure. Piping that does not allow sufficient space for proper installation of jointing material shall be replaced by one of proper dimensions. Blocking or wedging between bells and spigots will not be permitted.

D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

E. Pipe shall be cut by means of saws, power driven abrasive wheels, or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander, or abrasive disc.

3.5 FIELD TESTING

A. Field testing shall conform to the requirements of ASTM F794 and ASTM F949.

END OF SECTION

SECTION 33 95 50 - PVC PRESSURE PIPE, RUBBER JOINTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide polyvinyl chloride (PVC) pressure pipe, complete in place, as indicated in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

AWWA C104/A21.5	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110/A21.10	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water and Other Liquids
AWWA C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Appurtenances
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe 4-in Through 60-in for Water Distribution
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
PPI Technical Report TR 3/4	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
AWWA Manual M23	PVC Pipe - Design and Installation

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Submit drawings of pipe, fittings, and appurtenances.

2. Furnish manufacturer's literature for metallic locating tape.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide PVC pressure pipe conforming to the applicable requirements of AWWA C900, and the requirements indicated in this Section.

2.2 PIPE

A. Provide pipe of the indicated diameter and pressure class, complete with rubber gaskets.

B. Provide specials and fittings as indicated.

C. The dimensions and pressure classes for Dimension Ratios for large PVC pressure pipe with Cast-Iron Pipe Equivalent O.D.s shall conform to the requirements of AWWA C900.

D. Additives and Fillers

1. Unless otherwise allowed in alternate qualification procedures of PPI-TR3, compounds which have a Hydrostatic Design Basis (HDB) of 4000 psi at 73.4 degrees F and for water shall not contain additives and fillers that exceed the recommended values in Table 1, Part Y of PPI-TR3 (e.g., allowable content range for calcium carbonate is 0.0-5.0 parts per hundred of resin).

E. Joints

1. Joints for the buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint.

2. Provide the bell and coupling of the same thickness as of the pipe barrel, or greater thickness.

3. Provide the sealing ring groove in the coupling of the same design as the groove in cast iron fittings and valves available from local water works supply distributors.

4. Where indicated, provide ductile iron restrained joint pipe.

F. Joint Deflection

1. Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer.

2. No deflection of the joint will be accepted for joints that are over-belled or not belled to the stop mark.

2.3 PIPE DESIGN SCHEDULE

Pipe Designation or Pipe Class	Nominal Diameter, inches	Maximum Sustained Pressure, P_w, psi	Cover Range, feet	Trench Condition Outside Diam+feet	Minimum Compaction, percent
80-5	12-18	30	0-5	OD+2	90

2.4 FITTINGS

A. Provide ductile iron fittings conforming to the requirements of AWWA C110, Class 250.

B. PVC pipe fittings shall be mechanical joint.

C. Line and coat fittings in accordance with the requirements of Section 09 96 00 – Protective Coating.

D. Clearly label each fitting in order to identify its size and pressure class.

PART 3 -- EXECUTION

3.1 GENERAL

A. Material found to have defects will be rejected, and the CONTRACTOR shall promptly mark defective and remove such defective materials from the Site.

B. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements indicated herein.

C. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. Handling

1. Carefully inspect pipe, fittings, and accessories before and after installation, and reject those found to be defective.

2. Pipe and fittings shall be free from fins and burrs.

3. Before being placed in position, clean the pipe, fittings, and accessories and maintain them in a clean condition.

4. Provide proper facilities for lowering sections of pipe into trenches.

5. Under no circumstances drop or dump pipe, fittings, or any other material into trenches.

B. Storage

1. Store pipe, if possible, at the Site in unit packages provided by the manufacturer.

2. Exercise caution to avoid compression damage or deformation to bell ends of the pipe.

3. Store pipe in such a way as to prevent sagging or bending, and protect pipe from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe.

4. Store gaskets in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 – Earthwork.

3.4 INSTALLATION

A. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying.

B. Grade the pipe in straight lines, taking care to avoid the formation of any dips or low points.

C. Do not lay pipe when the conditions of trench or weather are unsuitable.

D. At the end of each day's WORK, temporarily close the open ends of pipe with wood blocks or bulkheads.

E. Supports

1. Support pipe at its proper elevation and grade, taking care to provide firm and uniform support.

2. Wood support blocking will not be accepted.

3. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with a recessed excavation in order to accommodate bells, joints, and couplings.

4. Provide anchors and supports where indicated and where necessary for fastening WORK into place.

5. Independently support fittings.

F. Use short lengths of pipe in and out of each rigid joint or rigid structure.

G. Replace piping that does not allow sufficient space for proper installation of jointing material with piping of proper dimensions.

H. Blocking or wedging between bells and spigots will not be accepted.

I. Install joints in accordance with the manufacturer's recommendations.

J. Keep trenches free of water until joints have been properly made.

K. The maximum combined deflection at couplings shall be in accordance with the manufacturer's recommendations.

L. Cutting

1. Cut the pipe by means of saws, power-driven abrasive wheels, or pipe cutters, which will produce a square cut.

2. Cuts by wedge-type roller cutters will not be accepted.

3. After cutting, bevel the end of the pipe using a beveling tool, portable type sander, or abrasive disc.

3.5 INSTALLATION OF COPPER WIRE

A. Provide polyvinyl chloride pipelines with No. 10 AWG bare copper wire, laid along the top of the pipe and held in place with ties or hitches of the same kind of wire and spaced not more than 13 feet apart, or metallic locating tape laid along the centerline of the pipe trench at a depth of 18 inches below finish grade.

B. Furnish manufacturer's literature, completely describing the tape proposed to be furnished.

C. No tape shall be used prior to receipt of written approval of the ENGINEER.

3.6 CONNECTIONS TO EXISTING WATERLINES

A. Locate existing pipelines and install the pipelines to the indicated depths.

B. Where sections of existing distribution mains are taken permanently out of service and abandoned in place, plug the cut ends solid with concrete to a depth of not less than one pipe diameter.

3.7 FIELD TESTING

A. Field testing shall conform to the requirements of Section 01 74 30 – Pressure Pipe Testing.

END OF SECTION

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SECTION 40 05 00 - PIPING, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings and as indicated in the Piping Schedule.

C. The Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Drawings are not pipe construction or fabrication drawings. The CONTRACTOR shall prepare pipe spooling and fabrication drawings and shall submit them to the ENGINEER for review.

D. Where pipe layout details are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

1.2 DEFINITIONS

A. Pipe, piping, pipe work, pipe system, piping system, or similar words, singular or plural shall mean and include, any type of pipes, tubes, fittings, valves, piping specialties, appurtenances, supports, restraints, anchors, coatings and linings and items related to piping.

B. Submerged piping, underwater piping or similar words, shall include any piping located two feet above water surface in basins or tanks

C. Potable water or similar words, shall mean and include any type of potable water or process water that be deemed potable after treatment processes.

D. Corrosive service shall mean and include in locations listed below:

a. Buried locations

b. Submerged locations or submerged piping.

c. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

d. Inside trenches, containment walls, and curbed areas

e. Locations indicated or designated in the contract documents.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Pipe spooling and fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Pipe Supports: Submit pipe support fabrication drawings including calculations in accordance with Section 40 05 07 - Pipe Supports.

3. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation, and restraint system if applicable.

4. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

5. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

6. Seals and Seating Materials: Submit elastomer material and manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

7. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.

C. Samples

1. Performing and paying for sampling and testing as necessary for certifications are the CONTRACTOR'S responsibility.

D. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

2. A certification from the pipe fabricator that each pipe will be manufactured subject to the fabricator’s or a recognized Quality Control Program. An outline of the program shall be submitted to the ENGINEER for review prior to the manufacture of any pipe.

1.4 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be marked as such, removed from the site, and replaced with new materials.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Extent of Work

1. Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. Materials in contact with potable water or process water that be deemed potable after treatment processes shall be listed as compliant with NSF Standard 61.

B. Piping Supports

1. Pipes shall be adequately supported, restrained, and anchored in accordance with Section 40 05 07 – Pipe Supports, and as indicated.

2. Piping support seismic and wind loads shall be sized in accordance with the design criteria as shown on GS-1 – General Structural Notes– Design Criteria– Seismic Loads.

C. Lining

1. Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated.

D. Coating

1. Application, thickness, and curing of coating on buried pipe shall be in accordance with the applicable Sections of Division 33 and Section 09 96 00 - Protective Coating, unless otherwise indicated.

2. Pipes above ground or in structures shall be coated in accordance with Section 09 96 00 – Protective Coating.

E. Pressure Rating

1. Piping systems shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

F. Inspection

1. Pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture, the ENGINEER shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. Tests

1. Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards.

2. The CONTRACTOR shall be responsible for performing material tests.

2.2 PIPE FLANGES

A. General

1. Flanges shall be provided with flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

2. Flange faces shall be perpendicular to the axis of the adjoining pipe.

3. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for those pipes.

B. Pressure Ratings

1. 150 psig or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4 In. Through 144 In., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2. Selection Based on Test Pressure

a. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.

C. Blind Flanges

1. Provide blind flanges in accordance with AWWA C207, or as indicated for miscellaneous small pipes.

2. Blind flanges for pipe diameters 12 inches and greater shall be provided with lifting eyes in the form of welded or threaded eye bolts.

D. Flange Coating

1. Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. Flange Fasteners

1. Unless otherwise shown on the drawings, or indicated in the applicable Sections of Divisions 33 and 40, Bolts and nuts shall conform to the following requirements;

a. Threads shall be in accordance with ANSI/ASME B1.1, Class 2, UNC for bolt diameters 1” and smaller and UN8 for bolt diameters greater than 1”.

b. Bolts shall have heavy hexagon heads and heavy hexagon nuts. Length of studs shall provide a projection of not less than 0.25 inch and no more than 0.5 inch through the nut when it is drawn tight.

c. Thread studs on flange connections are not permitted except where space restrictions preclude the use of standard bolts and where approved by the ENGINEER.

d. Through bolt holes shall be drilled in accordance with the applicable flange standard.

e. All bolts fastening metallic flanges shall be provided with plain washers installed under the nut. Washer materials shall be of the same material as the bolt. If the through bolt holes are drilled larger than the applicable standard by 1/8 inch in diameter or more, bolts shall be also installed with a plain washer under the bolt head as well.

f. All bolts fastening non-metallic flanges shall be provided with plain washers installed under both the bolt head and nut.

g. Washer materials shall be of the same material as the bolt.

h. Anti-seize compound shall be used on carbon steel fasteners, and shall be Husk-ITT, Husky 2000; or equal.

i. Anti-galling compound used for stainless steel fasteners in LOX, nitrogen injection, oxygen, ozone process/off-gas/vent and ozone contactor maintenance air service shall be DuPont “Krytox”; or equal.

j. Anti-galling compound used for stainless steel fasteners for other services shall be certified for potable water use and shall be Husk-ITT, Lube O’seal; Hercules, Real-Tuff; La Co, Slic-Tite; or equal.

2. Fastener Material Group Numbering System

a. Flange fasteners shall conform to the following material standards and shall be categorized within the Fastener Material Schedule Groups as indicated:

1) Material Group C1 (Carbon steel): ASTM A307 Grade B bolts, ASTM A563 Grade B nuts with ASTM F436 washers

2) Material Group C2 (Carbon steel): ASTM A193 Grade B7 bolts, ASTM A194 Grade 2H nuts with ASTM F436 washers

3) Material Group S1 (316 SS): ASTM A193, Grade B8M bolts, ASTM A194 Grade 8M nuts with Type 316 SS plain washers.

4) Material Group S2 (304 SS): ASTM A193, Grade B8 bolts, ASTM A194 Grade 8F nuts with Type 304 SS plain washers.

5) Material Group S3 (Hastelloy C-276): ASTM F468 N10276 bolts ASTM F467 N10276 nuts with type Hastelloy plain washers.

3. Fastener Material Group Numbers used in Non-Corrosive Service Applications

a. AWWA C115 ductile iron flanges - Material Group C1

b. AWWA C207 steel flanges - Material Group C2

c. ASME B31 group piping flanges – Material Group C2

d. Non-metallic pipe flanges - Material Group S1

e. Stainless steel pipe flanges and all others not listed above - Material Group S1

f. Where mating flanges are of different flange material standards and the specified Fastener Material Groups are in conflict, then fasteners of the higher grade shall be utilized unless otherwise indicated. For the purpose of this requirement, the Material Groups in order of decreasing grade shall be S1, C2, C1. Provide insulating flange sets for dissimilar metal flanged piping to electrically isolate the dissimilar piping.

g. Where gaskets of Teflon or Viton-A are required, fasteners of Material Group C2 shall be utilized for all C1 flange standards.

4. Fastener Material Group Numbers used in Corrosive Service Applications

a. All Flange fasteners shall be of Material Group S1 unless S2 and S3 are otherwise indicated on the drawings.

F. Insulating Flanges

1. Insulated flanges shall be provided with bolt holes 1/4-inch diameter greater than the bolt diameter.

G. Insulating Flange Sets

1. In order to prevent corrosion, insulating flange sets shall be furnished on all piping connections where two dissimilar metals are to be connected. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer.

2. For bolt diameters 1-1/2 inches or smaller, insulating sleeves and washers shall be one piece and shall be made of acetyl resin.

3. For bolt diameters larger than 1-1/2 inches, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic material.

4. Insulating flange sets materials used for fluids other than general water and wastewater shall be made of materials compatible with the fluid services.

5. Insulating gaskets shall be full-face.

H. Insulating Flange Manufacturer, or Equal

1. **JM Red Devil, Type E**

2. **Fluid Sealing Products, Inc.**

3. **Enpro Industries, Inc. (GPT)**

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full faced type in accordance with AWWA C207, suitable for temperatures to 700 degrees F, a pH of one to 11, and pressures to 1000 psig.

2. Blind flanges shall be provided with gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange.

3. Ring gaskets will not be accepted unless otherwise indicated.

4. Unless otherwise indicated, flange gaskets up to 150 psi shall be EPDM sheet material, NSF 61 approved, **Garlock, Style 98206-U (unbranded), or similar products from John Crane, or equal**.

5. Gaskets for flanged joints used in cryogenic oxygen (LOX and GOX) service shall be Teflon material, **Garlock Gylon, Style 3502 and 3503 or similar products from John Crane, or equal**.

6. Gaskets for flanged joints in PVC and CPVC piping used in general water and wastewater service shall be NSF 61 approved, full-faced, 1/8-inch thick, and made of fluoroelastomer having a durometer hardness of 50 to 70. Gaskets for pipe sizes up to 24-inch and 150 psi shall be Garlock Style XP or similar products from John Crane, or equal.

7. When the mating flange has a raised face, provide stainless steel flat ring gasket filler between the PVC flange and gasket and the adjacent flange.

8. Gaskets for flanged joints used in chemicals, hot air, ozone gas, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature. Consult gasket Manufacturer for recommended gasket material.

2.3 PIPE THREADS

A. Pipe threads shall be in conformance with ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

B. Unless otherwise indicated, use metal FNPT and plastic MNPT for threaded pipe connections between metal and plastic pipes.

2.4 THREADED INSULATING CONNECTIONS

A. General

1. Threaded insulating bushings, unions, or couplings, as appropriate, shall be furnished for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials

1. Threaded insulating connections shall be constructed of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.5 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required in order to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures.

B. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 degrees F, and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

C. Assemble the links using Type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

D. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

E. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal.

F. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

G. Modular Mechanical Seals Manufacturer, or Equal

1. **EnPro Industries Company (GPT), Link-Seal**

2. **Proco Products, Inc., Pen-Seal**

PART 3 -- EXECUTION

3.1 GENERAL

A. This section specifies the general installation requirements for piping, valves, and related items and shall be installed in accordance with the manufacturer's technical data and printed instructions. Specific piping materials, systems, appurtenances, and related installation and testing requirements are specified in related sections of Divisions 01, 33, and 40, and as noted on the Drawings, Pipe and Valve Schedules.

B. Piping shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, any existing pipes, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. CONTRACTOR shall obtain the assistance of the pipe manufacturer to instruct the pipe fitters in the correct installation and support of the piping system. Valves and flanges attached to the pipe shall be provided with adequate supports.

D. Lined Piping Systems

1. The lining manufacturer shall take full responsibility for the complete, final product and its application.

2. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

3.2 INSTALLATION

A. Installation shall be free from defects. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true straight. Ends of threaded pipes shall be reamed and filed smooth. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove. Fittings shall be equally cleaned before assembly.

B. Supports and Anchors: Piping supports, thrust, and seismic restraints shall be provided where shown on the Drawing or where determined to be required in according to Section 40 05 07 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Pipe shall be firmly supported with fabricated or commercial hangers or supports.

C. Piping Joints: Pipe joints requirements shall conform to the applicable piping sections of Division 33 and Division 40.

1. Threaded Joints: Pipe threads shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.

2. Flange Joints: Flanged joints shall be made with gaskets with bolts and nuts as specified. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

3. Fusion-Welded Joints: Fusion-welded joints shall be made with the manufacturer's recommended equipment on clean, dry pipe ends. The joints shall be made up at the recommended ambient temperatures, to the pipe manufacturer's written recommendations. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by fusion welded of pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe. Socket fusion, extrusion welding and hot gas welding shall not be used for field connections.

4. Push On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

5. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept closed at all times and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. PVC socket connections shall be joined with PVC cement conforming to ASTM D2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC). CPVC socket connections shall be joined with CPVC solvent cement conforming to ASTM F493. For chemical service applications, solvent cement shall be formulated and labeled for use on that chemical.

D. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

E. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment. Unless otherwise indicated for threaded pipe connections between metal and plastic pipes, use metal FNPT and plastic MNPT.

1. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

F. Isolation Joints / Dielectric Protection: Provide electrically isolate connections between dissimilar metal piping connections. Electrical checks shall be made to assure no contact is made between dissimilar metal piping elements.

1. Use dielectric couplings specially designed for the prevention of galvanic reaction between dissimilar metals.

2. For flanged connections, use stainless steel bolts with isolation bushings, washers, and full-face flange gaskets.

G. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction in order to avoid damage to embedded raceways and reinforcing bars.

H. Coating: Exposed pipes shall be coated with a finish coat to the pipe manufacturer's standard protective coating, with the manufacturer's recommended prime coat and a finish coat in accordance with Section 09 96 00 - Protective Coating.

I. Low points in piping systems and driplegs in steam, gas, and air systems shall have drainage valves.

J. Care shall be taken to insure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected.

3. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

4. Flange Bolts

a. Flange bolts shall be initially hand-tightened with the piping connections properly aligned.

b. Bolts shall be tightened with a torque wrench in a staggered sequence to the recommended torque for the applicable piping material per AWWA or manufacturer's recommendation. Care shall be taken to avoid over-torquing the bolts especially on plastic flanged joints.

c. Harness, thrust restraint, and tie rod bolts used for sleeve couplings, flange coupling adapters, or flexible joints shall be tightened gradually and equally at diametrically opposite sides until snug, in order to prevent misalignment and to insure that all studs carry equal loads.

d. In order to prevent induced stress or misalignment, do not over-torque connections to adjoining pump or equipment. Flanges shall not be deformed nor cracked.

3.3 INSPECTION

A. After completion of the WORK, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be in a clean and functional condition.

B. Inspection: Finished installations shall be carefully inspected for proper joints and supports, interferences, and damage to pipe, fittings, and coating. Temporary plugs and covers shall be removed from openings and floor drains. Defective WORK shall be repaired to the satisfaction of the field engineer or plumbing inspector.

3.4 FIELD TESTING FOR PRESSURE PIPING

A. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than two hours without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The CONTRACTOR shall furnish test equipment, labor, materials, and devices as part of the WORK. For additional testing requirements, refer to Section 01 74 30 - Pressure Pipe Testing.

B. Leakage may be determined by loss of pressure or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

END OF SECTION

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SECTION 40 05 02 - PIPING IDENTIFICATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide identification for the piping and valves, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASME A13.1 Scheme for the Identification of Piping Systems

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings: Provide a list of the suggested wording for each pipe label and valve tag, prior to fabrication.

C. Samples – Provide a sample of each type of identification device.

PART 2 -- PRODUCTS

2.1 EXPOSED PIPING OR ABOVE GROUND PIPING IDENTIFICATION

A. Pipe markers, type as indicated below, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

1. Marker Type

a. Snap Around: Vinyl or polyester sheet with UV- resistant ink, preshaped and sized to tightly curl around the pipe and remain in position.

b. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

c. Stencil: Lettering painted directly on surface of pipe inside color coded marker area.

2. Marker Area: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

3. Lettering: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

4. Arrows: At least one arrow at each marker area, showing direction of flow.

B. Pipe 1-inch diameter and smaller or pipe not suitable for the marker type(s) listed above shall be identified with aluminum or stainless steel pipe identification tags with stamped-in ¼" high identification lettering.

C. Manufacturer or Equal.

1. **Seton Identification Products**, Opti Code Pipe Markers (adhesive type)

2. **Grainger, Inc.** (adhesive, snap around)

3. **Marking Services, Inc.**(adhesive, snap around)

2.2 BURIED PIPELINE IDENTIFICATION

A. Underground Warning Tape

1. Material:

a. Polyethylene tape or polyolefin film. The material and ink shall be chemically inert and shall not degrade when exposed to acids, alkalis and other destructive substances commonly found in soil.

b. 6” wide tape with a minimum 4 mil thickness.

c. Message: “CAUTION, LINE BURIED BELOW” with the name of the fluid service in black lettering on a colored background.

1) Water: Blue

2) Sewer: Green

3) Gas and other services: Yellow

4) Other services: colors as approved by the OWNER.

2. Manufacturer, or Equal

a. **Reef Industries, Inc.**

b. **Seton Identification Products**

c. **T. Christy Enterprises, Inc.**

B. Tracer Wire

1. Material:

a. Solid copper conductor with 30 mil HMWPE.

b. 10 gauge or thicker wire.

2. Manufacturer, or Equal

a. **Kris-Tech Wire**

b. **Corrpro Companies, Inc.**

C. Witness Markers

1. Material:

a. UV resistant glass fiber and resin reinforced thermosetting composite material.

b. Constructed as a single pipe with pointer at the bottom end.

c. Message of the markers “CAUTION, LINE BURIED BELOW” with the name of the fluid service, and the following information:

1. Phone number for underground service alert.

2. Phone number for OWNER in case of emergency.

3. Application station number and offset information if marker is not directly over the pipe.

4. Name of buried appurtenance or fitting if applicable.

2. Manufacturers, or Equal

a. **Carsonite Composites, Utility Marker**

b. **Berntsen International, Inc.**

2.3 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the CONTRACTOR shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the system indicated herein.

2.4 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Valves and sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to the valves or short pipes.

C. Wording on valve tags shall describe the exact function of each valve (e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.) and include the valve number as indicated in the Contract Drawings. Wording on small pipes shall describe the contents of the pipe.

2.5 Pipe Coating:

A. Unless otherwise indicated, pipe coating shall be in conformance with Section 09 96 00 - Protective Coating.

PART 3 -- EXECUTION

3.1 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions, and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.2 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.3 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.

2. At least once in every room.

3. Within 2 feet of turns, elbows, and valves.

4. On the upstream side of tees, branches, and other distribution points.

3.4 IDENTIFICATION COLORS

1. Conform to the following color codes.

Color Schedule				
Pipe Contents		**Pipe Color**	**Marker Color**	**Letter Color**
Abbreviation	**Identification**			
D	Drain	White	Green	White
BW	Backwash	White	Green	White
OF	Overflow	White	Green	White
DWS	Domestic Water Supply (Chlorinated)	White	Blue	White
UW	Utility Water (Non-Potable)	Gray	Blue	White
R	Reuse Water	Green	Green	White
SW	Surface Water	Blue	Blue	White
WW	Well Water	Blue	Blue	White
F	Formalin	Black	Orange	Black
CHS	Chilled Water	Blue	Green	white

END OF SECTION

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SECTION 40 05 06 – PIPE COUPLINGS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide pipe couplings indicated, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 00 - Piping, General apply to the WORK of this Section

C. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings.

D. The couplings, adapters and joints shall be provided with restraining devices to restrict pipe axial movement. Where the restraining devices and/or details are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to provide the devices/details necessary to restraint the piping system.

E. The Items specified in this section include the following:

1. Groove Couplings
2. Sleeve Couplings
3. Flanged Coupling Adapters
4. Dismantling Joints
5. Transition Couplings.
6. Miscellaneous Adapters

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Product submittals, and shall be specifically identified with the applicable style or series designation, pressure rating and restraint system if applicable.
2. Couplings schedule or layout indicating where the couplings will be installed.
3. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and guides, including information on materials, temperature, and pressure ratings
4. Flexible Connectors: Submit pressure and thermal expansion calculations

C. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the CONTRACTOR.

1.3 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping couplings, adapters and joints accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Extent of Work

1. Piping couplings, adapters, joints and accessories shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. The CONTRACTOR shall not be allowed to substitute any other type of coupling in lieu of the couplings as specified herein unless approved by the ENGINEER.

3. The CONTRACTOR shall assign the responsibility to the coupling manufacturer to review the piping connection to the equipment and submit any modifications to the ENGINEER for review.

B. Pressure Rating

1. Couplings, adapters and joints shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

C. Seals

1. Seal elastomer materials shall be selected to be compatible with the fluid service, pressure and temperature. They shall be composed of elastomeric-compound material that will not deteriorate from age under normal storage or use conditions.

2. Where couplings are used in water containing dissolved ozone residual or chloramines, seal material shall be Viton-A.

D. Coating

1. Couplings shall be lined and coated at the factory, unless otherwise indicated.

2. Coating shall be in accordance with the Section 09 96 00 - Protective Coating, unless otherwise indicated.

2.2 SLEEVE COUPLINGS

A. General

1. Provide sleeve couplings specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

2. Couplings shall be constructed without pipe stop.

3. The middle ring shall be at least the same wall thickness as the pipe to which the coupling is connected and not less than 1/4-inch thick.

4. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. For standard sleeve couplings, the coupling shall be either 5 or 7 inches long for pipe diameters up to and including 30-inch and 10 inches long for pipe diameters greater than 30-inch. For long sleeve couplings, the coupling shall be 16 inches long for all pipe diameters.

6. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling.

C. Insulating Sleeve Couplings

1. Where insulating couplings are required, both ends of the coupling shall be provided with a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

D. Sleeve-Type Couplings Manufacturer, or Equal

1. **World Wide Metric, Inc.** (Dresser), Style 38

2. **Ford Meter Box Company, Inc.,** Style FC1 or FC3

3. **Smith-Blair, Inc.,** Style 411

2.3 FLANGED COUPLING ADAPTERS

A. Provide flanged coupling adapters specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012.

C. Flanged Couplings Adapter Manufacturer, or Equal

1. **Smith-Blair**, Model 913

2. **Dresser**, Model 128-W

3. **JCM**, Model 303

2.4 DISMANTLING JOINTS

A. Provide dismantling joints products specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012.

C. Dismantling Joints Manufacturer, or Equal

1. **Smith-Blair**, Model 975

2. **Dresser**, Model 131

3. **JCM**, Model 309

2.5 TRANSITION COUPLINGS

A. Provide transition-coupling products specifically designed suitable for the fluid service and manufactured for the piping applications.

B. The transition couplings shall have function and design similar to the flexible couplings, joint and flanged coupling adapters for connecting piping having different outside diameters.

2.6 MISCELLANOUS ADAPTERS

A. A special pipe adapter may be required to provide proper connection between different type of pipes and/or fittings. The adapter may be indicated on the Drawing with the pipe type or equipment. However, it is the CONTRACTOR'S responsibility to ensure proper connection between various type of pipes and pipe appurtenances. Provide adapters as required whether specifically indicated or not.

B. Provide piping adapter products specifically designed suitable for the fluid service and manufactured for the piping applications.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installation, inspection and field testing of the pipes shall in accordance with the requirements of Section 40 05 00 - Piping, General.

B. The CONTRACTOR shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation.

C. The CONTRACTOR shall assign the responsibility to the couplings manufacturer to review the piping connection to the couplings and submit any modifications to the ENGINEER for review.

3.2 INSTALLATION

A. Where couplings are shown to connect piping to mechanical equipment such as pumps, compressors, and blowers, the piping shall be aligned with the equipment point of connection and shall be perpendicular to the axis of the flange or fitting for which the piping is to be connected.

B. The couplings or the piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment.

C. Restrained Joints on couplings, adapters and joints

1. Couplings, adapters and joints on pressure lines shall be harnessed unless thrust restraint is provided by other means.

2. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA Manual M11, or as indicated.

3. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

4. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation in order to prevent misalignment of the pump imparted by the thrust within the piping system.

END OF SECTION

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SECTION 40 05 07 - PIPE SUPPORTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide pipe supports, hangers, guides, and anchors, complete and in place, as indicated in accordance with the Contract Documents.

B. Where pipe support systems are not indicated on the Drawings, the CONTRACTOR shall design and provide the supports in accordance with this Section. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing the pipe supports.

C. The provisions of this Section shall apply to piping in Divisions 33 and 40.

D. The CONTRACTOR shall provide supporting devices for supporting and restraining piping as indicated on the Drawings. Where pipe support devices and/or restraining details are not indicated on the Drawings, it is the CONTRACTOR'S responsibility to develop the details necessary to support and restraint the piping for a complete and functional pipe support system.

E. Seismic and Wind Forces

1. Pipe support details indicated in the Contract Drawings are sized for gravity loads only, and not designed to resist seismic and wind forces.

2. The CONTRACTOR shall arrange for the services of a registered professional engineer experienced in pipe support design to design such pipe supports to resist seismic and wind forces.

3. Piping support seismic and wind loads shall be sized in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Submit Shop Drawings which shall include the following information:

a. Drawings of pipe supports, hangers, anchors, and guides.

b. Pipe support schedule or layout indicating where the supports will be installed.

c. Where indicated, calculations for special supports and anchors, stamped and signed by a registered professional engineer in the state where the project is located.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Code Compliance

1. Piping systems and pipe connections to equipment shall be properly anchored and supported in order to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, and probable forces applied during construction as well as stresses on piping, equipment, and structures.

2. Supports and parts thereof shall conform to the requirements of ASME B31.1 - Power Piping – Chapter II, Part 5 -Expansion, Flexibility, and Pipe Supporting Element and design the pipe supporting elements in accordance with the rules of MSS SP-58 -Pipe Hangers and Supports – Materials, Design and Manufacture, except as supplemented or modified in this Section.

3. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members

1. Wherever possible, pipes shall be supported from structural members.

2. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the CONTRACTOR.

3. Supplementary members shall be in accordance with the requirements of the Building Code and the American Institute of Steel Construction, and shall be as acceptable to the ENGINEER.

C. Pipe Hangers

1. Pipe hangers shall be capable of supporting the pipe in operation, allowing free expansion and contraction of the piping and preventing excessive stress on equipment.

2. Hangers shall have a means of vertical adjustment after erection.

3. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe.

4. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves shall include hydraulic shock suppressors.

5. Hanger rods shall be subjected to vertical loading only.

D. Hangers Subject to Lateral or Axial Movement.

1. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement.

2. Where lateral or axial pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold-to-hot position

of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Riser Supports

1. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

F. Materials of Construction

1. Pipe support assemblies, including framing, hardware, and anchors, shall be of steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged supports, as well as piping, conduits, and equipment in hydraulic structures located two feet above water level, shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel, unless otherwise indicated.

G. Point Loads

1. Meters, valves, heavy equipment, and other point loads on PVC, FRP, or other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations, in order to avoid undue pipe stresses and failures.

2. In order to avoid point loads, the supports on PVC, FRP, or other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields for general service and Type 316 stainless steel shields for chemical or corrosive areas.

H. Concrete Anchors

1. Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table; consult the ENGINEER for any anchor applications not appearing on the table.

2. Anchor embedment shall be in accordance with the requirements of Section 05 05 19 Post-Installed Anchors in Concrete and Section 05 50 00 – Miscellaneous Metalwork.

Pipe Support Application	Type of Concrete Anchor
New Concrete	Use embedded concrete insert anchors on a grid pattern. Use **Grinnell (Anvil International), Tolco**, or equal.
Existing Concrete	Use non-shrink grouted anchors, expansion anchors, or epoxy anchors. Epoxy anchors are not permitted for vertical hanging applications or where sustained tension is exerted on the anchor. Exceptions: Expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where

	the concrete temperature is in excess of 100 degree F or higher than the limiting temperature recommended by the manufacturer.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors.

2.2 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads.

B. Where pipe spacing are indicated on the Drawings and are referenced to a Standard Detail, that requirement shall take preference over the general requirements of this section.

C. Pipe support spacing shall not exceed the maximum indicated spans. Piping with grooved joint couplings, flexible joints, and bend fittings shall be balanced supported by a minimum of two pipe supports per pipe length, one at near each joint/fitting.

D. For temperatures other than ambient temperatures or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations.

E. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of loading effects.

F. Ductile Iron Pipe

1. Install supports for ductile iron pipe in accordance with the recommendations of the Ductile Iron Pipe Research Association (DIPRA) Design of Ductile Iron Pipe on Supports.

2. As a minimum, where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing indicated in the following schedule:

Nominal Pipe Diameter, inches	Support Configuration
All diameters	two supports per pipe length, with one of the two supports located at a joint

G. Copper Tube

1. Where support spacing is not indicated on the Drawings, the CONTRACTOR shall use the spacing below:

Nominal Tube Size, inches	Support Spacing, feet	
	Water Service	Vapor Service
¾ and smaller	5	5
1	6	8
1-1/2 to 2-1/2	8	10
3	10	14
4	12	16
5	13	18
6	14	20
8	16	23

H. Schedule 80 PVC Pipe

Nominal Pipe Size, inches	Support Spacing, feet
1	5
1-1/2	5.5
2	6
3	7
4	7.5
6	9
8	9.5
10 and larger	10

I. Other Pipe Materials

1. Support spacing for pipe constructed of other materials shall be based on design temperature and in accordance with the pipe manufacturer's recommendations.

2.3 MANUFACTURED SUPPORTS

A. Stock Parts

1. Where not specifically indicated, designs that are generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.

2. Such parts shall be locally available, new, of best commercial quality, and designed and rated for the intended purpose.

B. Manufacturers, or Equal

1. **Basic PSA, Inc.**

2. **Bergen-Paterson Pipe Supports Group**

3. **Grinnell**

4. **Power Piping Company**

5. **TOLCO (Eaton B-Line)**

2.4 COATING

A. Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products and shall receive protective coatings in accordance with the requirements of Section 099600 – Protective Coating.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's printed instructions and per ANSI/MSS SP-58 Pipe Hangers and Supports- Materials, Design, Manufacture, Selection, Application and Installation.

2. Embedded concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. Appearance

1. Pipe supports and hangers shall be positioned in order to produce an orderly, neat piping system.

2. Hanger rods shall be vertical, without offsets.

3. Hangers shall be adjusted to line up groups of pipes at the proper slope for drainage and venting, as close to ceilings or roofs as possible, and without interference with other WORK.

3.2 FIELD FABRICATION

A. Quality Control

1. Field fabricated pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.

2. Hangers and supports shall be neat in appearance without sharp corners, burrs, or edges.

END OF SECTION

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SECTION 40 05 17 - COPPER WATER TUBE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide copper tube and appurtenances complete in place, in accordance with the Contract Documents

B. The requirements of Section 40 05 00 - Piping, General and Section 40 05 07 – Pipe Supports apply to the WORK of this Section.

C. Pipes, pipe fittings, and plumbing fixtures shall have no more than 0.25 percent lead in the wetted surface material.

PART 2 -- PRODUCTS

2.1 PIPE MATERIAL

A. Copper water tube shall conform to the requirements of ASTM B 88 - Seamless Copper Water Tube, and shall be hard drawn. Unless otherwise indicated, copper water tube shall be of Type K wall thickness.

2.2 JOINTS

A. Copper water tube shall have soldered joints or compression type joints. Soldered joints shall be made with 95 - 5 percent tin-antimony solder or with silver solder. Buried piping shall have flared or compression type joints. No soft-soldered joints will be allowed on buried piping. No solders containing more than 0.2 percent lead shall be used.

2.3 FITTINGS

A. Soldered Fittings: Soldered fittings shall conform to ASME B 16.18 - Cast Copper Alloy Solder Joint Pressure Fittings, or to ASME B 16.22 - Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings. The soldering flux shall be the manufacturer's approved type for the fitting and solder used.

B. Compression Fittings: Compression type fittings shall be brass fittings as manufactured by Crawford Company - SWAGELOK, Parker-Hannifin - CPI, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installation, inspection and field testing of the pipes shall in accordance with the requirements of Section 40 05 00 - Piping, General.

B. Where used for oxygen service the pipe shall be cleaned in accordance with Section 49 31 59 – Cleaning Requirements for Oxygen Service.

END OF SECTION

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SECTION 40 70 30 - INSTRUMENTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The contractor shall provide flow, pressure, level, analytical and temperature instrumentation and controls, complete and operable in accordance with the Contract Documents.

B. The Work under this Contract generally consists of supply, installation and putting into operation the instrumentation and control systems as indicated on the drawings and specified herein, and the scope of work as outlined below.

C. The support steel system necessary for electrical equipment, conduit, cables, and devices shall be part of the Contractor's scope. All concrete work associated with the install shall be coordinated with Division 03.

D. The Contractor shall review and understand the design and construction for the installation of equipment and raceways for pumps, instrumentation, Programmable Logic Controller (PLC), control panels, control requirements, and communication system.

E. The Contractor shall be responsible for the testing and commissioning of the entire installations under this Contract. During system commissioning a representative the Consultant, the Province, and the Contractor shall be present.

F. The Contractor shall be responsible for completing an organized and documented plan for equipment and instrumentation procurement and commissioning procedures.

G. The Contractor shall support the connection, testing, and commissioning of all vendor package instrumentation and controls components to provide for a complete and functional system. The Contractor shall engage the vendor to provide representatives to support this process as required.

H. Hatchery PLC, HMI, and SCADA programming shall be completed by the Owner's Controls Integrator.

1. Note: individual pre-packaged systems to be programmed by respective supplier.

I. The Contractor shall provide all control panels, junction boxes, and power cabinets, complete with all associated infrastructure and components as detailed throughout the engineered drawing package to provide for complete and functional system.

J. The Contractor shall be responsible for providing a fully functional control system, including verifying that all vendor packages are successfully integrated into the control system.

K. Coordinate commissioning and training requirements with Division 01 and each respective discipline Division of the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Division 1 – General Requirements

B. Division 23 – HVAC

C. Division 26 - Electrical

D. Division 27 – Communications & SCADA

E. Division 46 – Material Processing and Handling Equipment

F. Appendix A – Instrument Schedule

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Submittals shall be provided in accordance with the requirements specified in Section 01 33 00 – Contractor Submittals and Section 40 91 00 – SCADA Systems and Equipment.

B. Closeout Submittals shall include detailed instructions as required permitting effective operation, maintenance and repair.

C. Technical data:

1. Performance data for all instruments demonstrating compliance with

2. Illustrated parts lists with parts catalogue numbers.

3. Certified copy of factory test results.

1.4 INSTRUMENT TAGGING

A. The Instrument Tags are based on ANSI / ISA standards. If any equipment / instrumentation or controls are added or missing detailed tags within the package, the Contractor shall generate an appropriate tag based on ANSI / ISA format, confirm tag with the Consultant and Province, and apply labels as required in the Contract.

PART 2 -- PRODUCTS

2.1 INSTRUMENTS – GENERAL REQUIREMENTS

A. Provide each instrument with mechanisms that are corrosion resistant unless otherwise specified.

B. Provide each instrument with mechanisms enclosed in a dustproof and a moisture proof case.

C. Provide all indicator and gauge dials finished in permanent white with black graduations and figures.

D. Potentiometric signals shall have a "live" zero, or positive minimum value, in the signal range.

E. Each component shall be carefully selected and designed for a long lifetime with ample margin to withstand transient and other surge voltages which may occur in the circuits from any source in the power supply.

F. Each component and composite instrument shall be suitable for the location and installation position at the attitude designated on the drawings, e.g., horizontal, vertical, or sloped position.

G. The Contractor shall provide all power supplies. Provide each instrument having a 120 V(ac) supply with a receptacle and plug assembly where required. Receptacles and plug shall be of "twist-lok," type. Receptacle and plug shall be rated for the area of install.

H. Provide each instrument requiring power with a circuit breaker or fuse.

I. Integrating counters and elapsed time meters shall show the total quantity that has passed through the meter and shall not require the use of a multiplier other than cipher additions. The integrators shall have at least seven figures.

J. All control panel mounted instruments shall be suitable for flush mounting and shall be furnished with a bezel.

K. Unless otherwise indicated or specified, all analog signals shall be of the 4-20 mA DC type. This applies to both transmitting and receiving instruments.

L. All materials shall conform to the standards of the Canadian Standards Association (CSA), and the most recent version of the Canadian Electrical Code (CEC).

M. A minimum of one paper copy of each unique manual shall be provided.

N. Where instruments require a hand-held programmer for setting up and calibrating, one of each unique programmer shall be provided.

O. All instruments shall have Canadian certification(s).

2.2 DISSOLVED OXYGEN MEASUREMENT (MEMBRANELESS)

A. Dissolved Oxygen (DO) Measurement:

1. Description: Dissolved Oxygen (O2) and temperature indication

2. Measurement Technology: Membraneless .

3. Sensor measurement: Dissolved Oxygen, Temperature

4. Characteristics:

a. Wall mounted Transmitter – NEMA / CSA Type 4X, IP66 Rated, LCD Display

b. Power Supply: 24VDC

c. Analyzer shall be suitable for continuous automatic on-line analysis of the parameter specified for each analyzer under the conditions indicated.

d. The dissolved oxygen transmitter measuring system shall continuously monitor, indicate, and transmit the concentration of dissolved oxygen in an aqueous solution. The dissolved oxygen measuring system shall use an optical and/or

luminescent sensor technology for continuous measurement of dissolved oxygen, independent of water temperature or air pressure.

e. The analyzer shall operate satisfactorily in ambient temperatures between 0 and 30°C, or shall be provided with an isothermal enclosure so that the specified accuracy is not impaired. Relative humidity shall be from 5 to 95 percent, non-condensing.

f. Process fluid temperatures will range between 5 and 15°C.

g. Interconnecting cable between the sensor and the analyzer / controller / transmitter shall be either integral with the sensor or furnished by the instrument manufacturer and shall be of sufficient length to allow proper installation of the analyzer.

h. The analyzer and sensor shall be provided with all the necessary mounting and auxiliary hardware suitable for the intended installation application.

5. Dissolved Oxygen Sensor:

   a. The sensor shall be an optical type that enables the oxygen from the sample to diffuse into the sensor's fluorescence or luminescence coating, which in turn responds to the sensor's LED light. The fluorescence intensity reduction is proportional to the DO concentration in the sample. The sensor shall have no membrane or electrodes to replace and shall not require filling solutions. The sensor shall be automatically temperature compensated.

   b. The measurement shall be performed using a sensor that is immersed in the process.

   c. Measurement range shall be 0-20 ppm.

   d. The sensor shall have an accuracy of ±0.1 ppm between a range of 0-5 ppm and +/- 0.2 ppm for ranges above 5 ppm. Resolution shall be 0.01 ppm.

6. Temperature Sensor:

   a. Integral to Dissolved Oxygen sensor probe

   b. Type NTC 30K thermistor or equivalent

   c. Temperature Range: 0-30°C (configured on transmitter as 4-20mA output)

7. Analyzer Controller/Transmitter

   a. The analyzer system shall be provided with a controller/transmitter unit that shall accept and process the input from minimum two (2) digital analyzers/sensors to produce the required output(s).

   b. The controller shall use a menu-driven operation system and an auto-ranging digital alphanumeric display. The controller shall have at least two user security levels.

c. Analyzer system enclosure shall be mounted within a locking NEMA / CSA Type 4X enclosure mounted on a stainless-steel strut channel stand. The analyzer system enclosure shall be rated for the intended installation application.

8. Controller Output:

a. For each analyzer/sensor the controller shall generate an isolated 4-20 mA DC linearly proportional to the calibrated range and capable of driving a minimum of 500 Ohms load. Analog signals to be connected to site PLC.

b. A minimum of three programmable SPDT relay outputs shall be provided for user configurable. Contact ratings shall be 120V(ac) or 30 V(dc), 5 Amps. Connect transmitter fault status to site PLC.

9. Equipment mounting and support:

a. Provide a mounting assembly for the oxygen sensor and transmitter. Provide manufacturer standard mounting equipment for sensor, such as a universal holder and chain assembly compatible with equipment. Install sensor mounting equipment to hand railing or, where hand railing not available, provide an upright post system fabricated from strut or railing material and anchored to the top of the concrete wall.

10. Refer to Appendix A – Instrument Schedule.

11. Manufacturer's:

a. Endress & Hauser Oxymax COS61D sensor, Liquiline CM442/444/448 multiparameter transmitter.

b. Approved equivalent.

2.3 FLOW MEASUREMENT

A. Magnetic Flow Meter:

1. Size: As indicated on drawings

2. Flow Meter Characteristics:

a. Wall mounted Transmitter – NEMA / CSA Type 4X, IP66 Rated, LCD Display.

b. Process Install: Inline flow measurement transducer head mounted in process line.

c. Continuous zero stability.

d. Interchangeability with signal converters without calibration performance.

e. End connections shall be compatible with process piping specifications and drawings

f. Grounding as specified by the flow meter manufacturer. Grounding rings shall be required.

g. Signal converters shall have the following features:

1) Continuous zero stability.

2) Solid state electronics.

3) Direct reading range adjustment permitting precise manual selecting of maximum flow rate.

4) One (1) 4-20 mA scalable output for instantaneous flow.

5) One (1) Pulse output for totalized flow (Whenever a preset volume passes through the flow meter, there is a pulse output)

6) Interchangeability with any flow meter without affecting calibration performance.

7) Power supply: 120VAC

8) The combined accuracy off the flow meter and converter shall be within 0.5% of the actual flow rate, when the actual flow rate is between 10% and 100% of the maximum flow setting at steady state conditions.

h. Provide pipe spool pieces for the in-line replacement of each flow meter. Spool piece tube and end connections shall conform to the process piping specifications and drawings.

i. Flange ratings shall be as indicated by Process Mechanical.

j. Instrument measurement range varies. Refer to Appendix A – Instrument Schedule.

k. Acceptable manufacturers:

1) Krohne: OPTIFLUX 2300 or 6000 c/w IFC 100 Transmitter.

2) Endress+Hauser: Proline Promag W 400 c/w Transmitter.

3) Rosemount: 8705 Flow Sensor and Transmitter.

4) Siemens / SITRANS: 5100 W c/w 5000/6000 Transmitter.

5) Approved equivalent.

B. Clamp-On Ultrasonic Flow Measurement:

1. Size: As indicated on drawings.

2. Location: Verify placement on site based on manufacturer's recommendation for upstream and downstream pipe diameters required for measurement and accuracy.

3. Characteristics:

   a. Process Install: Pair of clamp-on meters attached to pipe based on manufacturer's recommendations.

   b. Clamp-on Transducer: IP68, encapsulated design c/w banding for process piping and coupling pads.

   c. Transducer Cable: Vendor supplied extension cable from transducers on process pipe to wall mountable transmitter at eye level. Cable to be double shielded, 10m cable length.

   d. Provide mounting tracks for installation of transducers.

   e. One (1) 4-20mA scalable output for instantaneous flow.

   f. Totalizer Pulse: 50ms (minimum) Pulse.

   g. Power supply: 120VAC

   h. Junction box for cable extension of flow transducers as required.

   i. Wall mounting bracket or instrument stand near meter.

   j. Cable glands for vendor cables.

   k. Performance:

      1) Temperature: 0-50^{o}C

      2) Accuracy: +/- 1% of reading.

      3) Repeatability: 0.15% of reading.

      4) Linearity: 0.5%.

   l. Approvals: CSA (or equivalent).

   m. Instrument meansurement range: 0-600gpm. Refer to Appendix A – Instrument Schedule.

   n. Acceptable Manufacturers:

      1) Siemens

      2) Endress & Hauser

      3) Approved equivalent.

2.4 ISOLATION VALVES

A. Each instrument sensing line shall be complete with an isolation valve. The isolation valves shall conform to Division 43 - Process Mechanical and all pertinent Sections of Division 40.

2.5 LEVEL MONITORING

A. Hydrostatic:

1. Description: Level measurement via submersible hydrostatic level sensor.

2. Locations:

   a. Inside of the existing well casing (12-inch ID).

3. Transmitter shall be of a maintenance-free, hermetically sealed design.

4. Water Storage Tank: Transducer / antenna shall be of made out of corrosion-resistant materials for water

5. Where submersible transducer type is indicated, the level measurement system shall consist of a submersible transducer, electronic transmitter, support cable, and interconnecting cable with cable shield and vent tube for atmospheric reference. The vent tube shall be provided with a replaceable moisture barrier. The submersible transducer shall be the strain gauge type suitable for sensing pressure equivalent to the liquid level range indicated. The transducer shall have 316 stainless steel process wetted parts (including sensor housing and membrane) and shall be furnished with a waterproof interconnecting cable. Cable airline shall have diaphragm seal. The transducer shall be suspended by a corrosion resistant cable as recommended by the manufacturer. Fill fluid shall be manufacturer offered synthetic oil. Max over presssure limit: 600psi; max turn-down: 100:1.

6. The installation shall allow easy removal of the transducer and cable assembly for maintenance purposes. The electronic level transmitter shall be remote mounted and shall produce a 4-20 mA DC signal linearly proportional to the level range indicated. The unit shall be complete with weatherproof enclosure, zero and span adjustments and the measurement system shall be suitable for operation over a temperature range of 32 to 122 degrees Fahrenheit with an accuracy of plus or minus 0.5 percent of span. The unit shall support the HART protocol.

7. Submersible level transducers and transmitters shall be as manufactured by:

   a. Endress & Hauser, Waterpilot FMX21 Series

   b. Rosemount (Delta-Mobrey) 9700 Series

   c. Or Engineer approved equal.

8. For tank applications, furnish probe with 316 SS ANSI Class 150 flange with 1-inch NPT bore, water-tight seal and cable grip. Contractor shall furnish sufficient sensor cable to allow for remote mount of indicating transmitter.

9. Refer to Appendix A – Instrument Schedule.

B. RF (Capacitance) Type Level Measurement:

1. Description: Level measurement via RF capacitance probe in Diesel fuel storage tank

2. Locations: Diesel storage tank

3. Level sensor rated for No.2 Diesel.

4. The level measurement system shall consist of a rigid sensing element, a two-wire electronic Smart transmitter (HART compatible), a three terminal inter-connecting cable, and radio frequency filters. The transmitter shall be a solid-state unit with 4-20 mA output into 500 ohms (minimum), linear to level. The transmitter shall have non-interacting zero and span controls, a local indicator scalable in the desired process variable, and be housed in a NEMA 4X enclosure. The level measurement shall not be affected by changes in process conductivity or by more than 3 inches with a 1/32-inch coating build-up of a 1000 micro material on the sensing element. The transmitter shall measure the capacitance/admittance generated by the process on the sensing element.

5. The sensing element shall be chemically resistant to the process fluid. It shall be supplied with a supplemental 3/8" ground rod of Hastelloy C. The sensing element shall be flange mounted. The flange shall be chemically resistant to the process and, if necessary, contain either the concentric shield or ground rod.

6. The inter-connecting cable shall be a temperature-stabilized coaxial cable with molded ground. The cable shall be capable of field shortening without affecting the system calibration, and shall be intrinsically safe.

7. For tank installations, probe cable length shall be specific to the tank depth allowing for a taut installation with no part of the cable or cable weight in contact with the tank bottom

8. RFI filters shall be supplied by the system manufacturer and shall be field mounted on the sensing element input and transmitter output.

9. Level measurement system shall be as manufactured by:

    a. Endress and Hauser

    b. Delta- Mobrey

    c. Or Engineer approved equal.

10. Refer to Appendix A – Instrument Schedule.

C. Radar (non-contact)

1. Transmitter shall be of a maintenance-free, hermetically sealed design.

2. Transducer / antenna shall be of made out of corrosion-resistant materials (such as polypropylene) and be suitable for water applications.

3. The transducer shall be mounted according to the engineered drawings and in coordination with the manufacturer's installation requirements.

4. Transducer / antenna shall be installed on a bracket system in coordination with the detailed drawings, complete with submergence shield.

5. Characteristics:

a. Panel mounted on instrument display board– NEMA / CSA Type 4X, IP66 Rated, Polycarbonate.

b. LCD Display.

c. Powered by 24VDC

d. Total Beam Angle: 10° (Maximum).

e. (1) 4-20 mA scalable output for level monitoring of DAB.

f. Transmitter shall contain a minimum of three (3) relays, with one (1) relay reserved for producing a digital signal for instrument fault. Relay to fail open.

g. Splash / submergence shield on radar sensor.

h. Approvals: UL (or equivalent).

i. Instrument Measurement Range: Refer to Appendix A – Instrument Schedule.

j. Instrument shall be furnished with manufacturer recommended 316L SS mounting bracket. Note: where used to measure level of an aerated surface, the transmitter shall include the advanced dynamics option (or Rosemount equivalent) to ensure measurement accuracy and repeatability within manufacturer published specification.

6. Exact process range to be set on site based on DAB height. Verify with process mechanical. Fine tune range in coordination with Controls Integrator.

7. The integral cable supplied with the radar level instrument shall be terminated in a Type 4X weatherproof junction box above the DAB and routed to the transmitter on the instrument panel board as required.

8. Install radar transducer in an area not affected by the transducers beam angle.

9. Acceptable Manufacturers:

a. Endress & Hauser Micropilot FMR5x Series with FHX 50 Nema 4X remote display and up to 100-ft of manufacturer cabling.

b. Rosemount 5408 Series with Model 71 Nema 4X remote field signal indicator and up to 100-ft of manufacturer cabling.

c. Or Engineer approved equal.

D. Float Type Liquid-Level Switches

1. Liquid level (mercury-free) switches shall be the side mounted float actuated type. Float switches shall be SPDT and shall consist of a fixed sealed reed switch actuated by a floating magnet. Level switches shall be flange or plug mounted to suit field requirements. Process wetted materials shall be Teflon.

2. Acceptable Manufacturers:

a. MAGNETROL “TUFFY”

b. Or Engineer approved equal.

3. Refer to Appendix A – Instrument Schedule.

E. Flipping Float Level Switches

1. Flipping float (mercury-free) level switches shall consist of a switch, a moving float, and a connecting cable which is anchored at the midpoint of a differential band. As the level rises and falls the float rights itself or inverts causing switching actions. The cable anchoring point shall be protected by strain relief. The hermetically sealed switches shall be SPDT with a minimum rating of 10 Amps at 120 VAC. Process wetted materials shall be Teflon.

2. Flipping float level switches shall be manufactured by:

a. MAGNETROL Model T10

b. Or Engineer approved equal.

3. Refer to Appendix A – Instrument Schedule.

F. Displacer Type Level Switches

1. Displacer type level switches (mercury-free) shall be equipped with SPDT switches actuated by Karbate displacers. Each of the two switches on the tandem unit shall be independently actuated by adjusting each of the fixed narrow level displacers along the suspension cable. Displacer suspension cable shall be constructed of 316 stainless steel. The switch shall have a 3-inch, 150-lb mounting flange.

2. Displacer type level switches shall be manufactured by:

a. MAGNETROL Model B15

b. Or Engineer approved equal.

3. Refer to Appendix A – Instrument Schedule.

G. Flow Meter, Submerged Area-Velocity for Open-Channel

1. Submerged area-velocity flow meter for open channels.

2. Furnish and install the flow measurement equipment and accessories as indicated on the plans and as herein specified.

3. Meter shall directly measures flow velocity and level of open-channels or partially filled pipes without a primary device such as a flume or weir.

4. Preprogrammed tables in meter of channel shapes including: round radius, U-shape, rectangular, trapezoid, egg-shape and custom channels.

5. Transmitter:

a. Transmitter shall be capable of sending and receiving signals from a Doppler velocity sensor and any level sensor with a 4…20 mA output in order to compute the flow velocity profile, volumetric flow rate and total. Readings can be displayed on an LCD display and output to a SCADA system, PLC or BAS using various analog, digital and communication outputs.

6. Velocity Sensor with Integrated Level Sensor

   a. Velocity sensor shall be a submerged Doppler ultrasonic sensor with pulse spectral correlation to measure the flow velocity at multiple points in the channel.

   b. Velocity sensor shall be integrated with a level sensor and temperature sensor in a single package.

7. Operational Requirements

   a. Flow Transmitter

      1) Meter Housing: Die-cast power coated aluminum, IP66, Type 4X

   b. Channel Selection

      1) Round radius

      2) U-shape

      3) Rectangular

      4) Trapezoid

      5) Egg-shape

      6) Custom channels

   c. Power

      1) 10-30VDC, +/- 15%, 5% residual ripple, maximum 30W, typical 8W.

   d. Display

      1) Four line × 20 character

      2) Selectable measurements to display, including

         a) Flow rate

         b) Totalizers

         c) Level

         d) Temperature

         e) Status

e. Configuration

1) Webserver with WiFi or Ethernet LAN connectivity to laptop or mobile device

f. Cable connection

1) Supply and signal cables 2 x M20

2) From meter M20

g. Ambient temperature

1) –4…140° F (–20…60° C)

h. Analog outputs

1) Four 4…20 mA active

2) Load less than 550 Ohm

i. Analog inputs

1) Four 4…20 mA

2) One reserved for optional external level sensor

j. Digital outputs

1) Two open collectors

2) Passive

3) 24V DC

4) Pulse or frequency

k. Four solid-state relay

1) Normally open/normally closed

2) Maximum 60V DC, 1 A

3) Maximum 30V AC, 200 Hz maximum, 1 A

l. Digital input

1) Two 30V DC maximum input

m. Communication

1) RS485 Modbus RTU

2) Modbus TCP/IP Ethernet

n. Programming port

1) Wi-Fi

2) Ethernet 10/100 Mbps RJ45

o. Datalogger

1) 12 month capacity

2) Log date/time, all measurements, all inputs/outputs and status

3) Transfer log file through web browser or FTP client

p. Security

1) User name and password login to program meter

2) Languages: English, French, German, Spanish, Czech, Polish, Russian and Japanese

q. Certifications

1) CE, RoHS

2) cCSAus for general area

8. Area-Velocity Sensor

a. Liquid Types

1) Unpressurized wastewater with greater or equal to 50 ppm with minimal foam in open channels or partially filled pipes.

b. Velocity Sensing

1) Sensor shall use Pulse Coherent measuring principle

2) Sensor shall sample flow velocity at approximately 0.8 in (20 mm) increments with a maximum of 32 cells

3) Velocity range

a) ± 0.14…± 17.4 ft/s (± 0.04…± 5.3 m/s) minimum detectable flow velocity depending on size and amount of particles

4) Velocity accuracy

a) ± 2% of reading in the range 5.0…16.5 ft/s and –5.0…–16.5 ft/s (1.5…5.0 m/s and –5.0…–1.5 m/s)

b) ±0.1 ft/s in the range –5.0…5.0 ft/s (± 0.03 m/s in the range –1.5…1.5 m/s)

5) Beam angle

a) 45°

c. Water Level Sensor

1) Water level sensor integrated with velocity sensor

2) Level range

a) 1.6…51 in. (0.04…1.3 m)

3) Level accuracy

a) ± 0.5% full scale

d. Temperature Sensor

1) Temperature sensor integrated with velocity sensor

2) Temperature accuracy

a) Temperature sensor integrated with velocity sensor

b) Temperature accuracy

e. Operating Temperature

1) 5…122° F (–15…50° C)

f. Construction

1) Material

a) Stainless steel (main unit, base plate)

b) PEEK (Piezo Oscillator cover lid)

2) Protection Class

a) IP68

3) Height

a) Maximum 0.9 in. (22 mm) including base mounting plate

g. Cable

1) Length

a) 32…262 ft (10…80 m)

2) Jacket material

a) Polyethylene

3) Operating Temperature

a) –4…158° F (–20…70° C)

H. Paddle Flow Switches

1. Paddle switches shall be activated by paddles in a pipe flow stream. Wetted materials shall be 316 SS. Minimum pressure rating shall be 250 psi. Unit shall have two SPDT switches rated 20 VA minimum. The actuation point between "flow" and "no flow" shall be adjustable. Flow switches shall be suitable for use in the indicated pipe sizes and shall have a 1 1/2-inch MNPT process connections.

2. Flow switches shall be installed horizontally and upright with threaded tee connection with no less than 5 pipe diameters upstream and downstream of the instrument. Flow switches shall be rated Nema 4X or Nema 7 as required by the installation area classification.

3. Refer to Appendix A – Instrument Schedule.

4. Flow switches shall be as manufactured by:

a. McDonnell & Miller Series FS7-W, FS7-4W or FS7-4E (depending on area classification)

b. Or Engineer approved equal.

2.6 PRESSURE MONITORING

A. Pressure Indicating Transmitters:

1. Description: Discharge pressure monitoring

2. Pressure transmitter shall have the following features:

a. Loop powered by 24 V(dc).

b. Output analog signal shall be 4-20 mA and linearly proportional to the pressure.

c. Where an indicator is required, it shall have a linear scale in units of psi.

d. Transmitter shall have a direct mount flanged diaphragm seal attached to the bottom of the transmitter. The diaphragm shall be flush with the flange. The piping ahead of the transmitter shall have a ball valve for isolation. Minimum inlet piping size to be ¼" with minimum 1" main line process connections.

e. Pressure transmitters shall have adjustable range of 0.45 ~ 600 psi, with calibrated range of 0 – 200 kPa. See Appendix A at the end of this specification.

f. Pressure transmitters exact model number to be selected in coordination with the process system pressure ratings.

3. Acceptable Manufacturers:

   a. Endress+Hauser.

   b. Siemens.

   c. Rosemount.

   d. ABB.

   e. Approved alternate.

4. Refer to Appendix A – Instrument Schedule.

B. Pressure Gauges:

1. Pressure gauges shall be 4-1/2 inches in diameter, liquid-filled, bottom connected, with white laminated dials and black graduations. Windows shall be shatterproof glass. Gauges shall have a blowout disc and be encased in phenolic, steel or cast iron. Measuring element shall be a stainless-steel bourdon tube with welded, stress-relieved joints. Socket shall have wrench flats. Movement shall be rotary geared, all stainless-steel material. All pressure gauges shall be provided with a pulsation snubber constructed of 316 stainless steel and a ball isolation valve. Accuracy shall be plus or minus 0.5 percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected.

2. Pressure gauges shall be as manufactured by:

   a. Ashcroft 1279

   b. Ametek Solfrunt Series 1900

   c. Or equal.

3. Refer to Appendix A – Instrument Schedule.

2.7 TEMPERATURE MONITORING

A. Temperature Indicating Transmitter:

1. Description: Temperature monitoring of process fluid from Chiller System CHS-510 process line.

2. Line Size: 3-Inch

3. Line Type: PVC.

4. Measurement Technology: RTD temperature probe (within Thermowell).

5. Measurement: Chilled water.

6. Location: Verify placement on site.

7. Characteristics:

a. Process Install: Thermowell threaded RTD into process line.

b. Industry standard Platinum-100, single element type sensor in a shield sheath. It shall be an insertion type and provided with a thermowell as an assembly from the same manufacturer. The RTD and the thermowell shall be compatible in size and connection.

c. Standard thermowells shall be 316 stainless steel.

d. RTD shall have a 3 or a 4-wire configuration as recommended by the manufacturer for the intended service and installation application

e. The RTD shall be NEMA 4X in a 1/4-inch Type 316 stainless steel sheath with watertight potting.

f. Thermowell:

1) The thermowell shall be provided to protect the RTD sensor installed in the process. The thermowell insertion length shall be as required by intended service and installation application, not exceeding the manufacturer's published recommendations for the allowable length and for the line velocity and as indicated in the data sheet.

2) Standard thermowells shall be 316 stainless steel. For corrosive environments material shall be as recommended by the manufacturer for the intended service and installation application as indicated in the data sheet.

3) Thermowell style and material shall be as required by the installation application and as recommended by the manufacturer as indicated in the data sheet. Process connections shall be threaded, flanged or welded, as required by the installation application and as indicated in the data sheet. Flanged thermowells, where required, shall meet material and size requirements of the line classification

g. Connection Head: The connection head shall be weatherproof.

h. Temperature Range: Refer to Appendix A – Instrument Schedule.

i. Acceptable Manufacturers:

1) Rosemount.

2) Foxboro.

3) Endress & Hauser.

4) ABB.

5) Honeywell.

6) Siemens.

7) Approved alternate.

B. Temperature Guages

1. Bi-metal, Nema 4X, hermetically sealed temperature gauges with 304 stainless steel casing shall be furnished as detailed in the instrument schedule and installed in accordance with the manufacturer requirements. Furnished gauges shall be 3-inch diameter and scaled in Fahrenheit. Gauges shall be as manufactured by:

   a. Wika, Model TI-32

   b. Or Engineer approved equal.

2. Refer to Appendix A – Instrument Schedule.

2.8 Solenoid Control Valves on:

A. Formalin Supply Pipe – SOV-5501

1. Standard Voltages: 120 V(ac)

2. Solenoid States: Normally Open (NO) when de-energized or loss of power.

3. Refer to detailed Drawings for solenoid control station requirements and installation details.

4. Manufacturer:

   a. ASCO Red Hat.

   b. Approved alternate.

5. Refer to Appendix A – Instrument Schedule.

2.9 POWER DISTRIBUTION AND CONTROLS SYSTEMS MONITORING

A. Provide monitoring of all surge protection devices, UPS systems, power supplies, active harmonic filtering unit, PLC control panel equipment monitoring statuses, and field control stations as outlined within the detailed Drawings and as specified herein. Provide all controls cabling as required to complete the connections to the PLC(s).

2.10 SPARE PARTS

A. The following instruments are required to be purchased within this Contract but not installed, for storage onsite:

1. AE-SPARE01 Spare O2 Sensor

2. AIT-SPARE01 Spare Dissolved O2 Indication Transmitter (2 Channel)

3. LS-SPARE01 Spare Level Switch

4. LE--SPARE01 Spare Radar Transducer

5. LIT-SPARE01 Spare Radar Level Indication Transmitter

6. PI Spare Pressure Guage

7. PIT-SPARE01 Spare Pressure Indication Transmitter (0 – 2000 kPa range minimum)

8. TI-SPARE01 Spar Temperature Guage

9. TIT-SPARE01 Spare Temperature Indicating Transmitter

PART 3 -- EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Verify and confirm all installation locations on site.

B. Install all instruments and systems in accordance with the manufacturer's recommendations.

C. Provide all components for complete and functioning instrumentations system.

D. Sensor cables connecting to the transmitter shall be installed above grade in watertight conduit.

E. Coordinate with the Controls Systems Integrator and the Province for signal connection of new instrument systems.

F. Refer to detailed Drawing package for additional specific details surrounding the installation of process instruments.

3.2 TESTING AND COMMISSIONING OF EQUIPMENT

A. Refer to Section 40 70 20 – Instrumentation General Provisions and Section 40 80 00 – Commissioning of Process Systems for testing and commissioning requirements of instruments and the respective control signals.

3.3 FIELD QUALITY CONTROL

A. Level measuring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 SCADA Systems and Equipment. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 SCADA Systems and Equipment.

END OF SECTION

40 70 30 ATTACHMENT A - BATTLE CREEK INSTRUMENT LIST

Drawing Number	Instrument Tag	Instrument Type	Req. Power Supply	Instrument Range	Instrument Setpoint	Installation Detail	Specification	Comments
1I-1	LE-101 / LIT-1101	Fuel Storage Tank Level Transmitter (Capacitance)	Confirmed by Generator Supplier				40 70 30	Instrument range based on final height of fuel tank (confirmed by supplier)
1I-1	LSHH-1102	Fuel Tank High High Level Float Switch - Leak Detection	Confirmed by Generator Supplier				40 70 30	Instrument range based on final height of fuel tank (confirmed by supplier)
2I-1	LE-2101 / LIT-2101	Well Hydrostatic Level Transmitter and Hydrostatic level sensor	Confirmed by Well Water Supplier				40 70 30	Instrument range based on final height of well (confirmed by supplier)
2I-1	PI-2101 / PIT-2101	Well Pump Discharge Pressure Transmitter and Pressure Guage	24 VDC	0-200 psi	N/A	GI-8/GI-12	40 70 30	
3I-2	LE-3201 / LIT-3201	Intake Structure Radar Level Transmitter	24 VDC	0-15 ft	N/A	GI-7 /GI-12	40 70 30	Confirm final mounting height on site
3I-2	LSHH-3202	Intake Structure Level Switch High High	24 VDC	On/Off	N/A	GI-6/GI-12	40 70 30	Confirm final mounting height on site
3I-3	PI-3301 / PIT-3301	Intake Pump P-301 Discharge Pressure Transmitter	24 VDC	0-100 psi	N/A	GI-8/GI-12	40 70 30	
3I-3	PI-3302 / PIT-3302	Intake Pump P-302 Discharge Pressure Transmitter	24 VDC	0-100 psi	N/A	GI-8/GI-12	40 70 30	
3I-3	PI-3303 / PIT-3303	Intake Pump P-303 Discharge Pressure Transmitter	24 VDC	0-100 psi	N/A	GI-8/GI-12	40 70 30	
3I-3	FSL-3301	Intake Pump P-301 Low Paddle Type Flow Switch	24 VDC	On/Off	N/A		40 70 30	
3I-3	FSL-3302	Intake Pump P-302 Low Paddle Type Flow Switch	24 VDC	On/Off	N/A		40 70 30	
3I-3	FSL-3303	Intake Pump P-303 Low Paddle Type Flow Switch	24 VDC	On/Off	N/A		40 70 30	
3I-3	FE-7103 / FQIT-7103	Outfall Area-Velocity Meter	24 VDC	0-7200 gpm	N/A		40 70 30	
4I-1	FE-2101 / FQIT-2101	Well Pump Magnetic Flow Transmitter	24 VDC	0-400 gpm	200 gpm	GI-4	40 70 30	
4I-1	AE-2101 / AIT-2101 / TE-2101	Well Water Storage Tank Dissolved Oxygen Analyzer / Temperature Indication	24 VDC	0-20 ppm	N/A	GI-12	40 70 30	Confirm final mounting height on site
4I-1	LE-2102 / LIT-2102	Well Water Storage Tank Radar Level Transmitter	24 VDC	0-20 ft	14 ft	GI-7 /GI-12	40 70 30	Confirm final mounting height on site
4I-1	LSHH-2102	Well Water Storage Tank High High Level Switch	24 VDC	On/Off	EL 72.00	GI-6/GI-12	40 70 30	Confirm final mounting height on site
4I-3	FE-4101 / FQIT-4101	Pumped Intake Magnetic Flow Transmitter	24 VDC	0-7200 gpm	Varies	GI-4	40 70 30	
4I-4	LE-4101 / LIT-4101	Water Supply Headbox Radar Level Transmitter	24 VDC	0-15 ft	11 ft	GI-7 /GI-12	40 70 30	Confirm final mounting height on site
4I-4	LSHH-4401	Water Supply Headbox High High Level Switch	24 VDC	On/Off	EL 65.00	GI-6/GI-12	40 70 30	Confirm final mounting height on site
4I-4	AE-4401 / AIT-4401	Water Supply Headbox Dissolved Oxygen Analyzer	24 VDC	0-20 ppm	N/A	GI-12	40 70 30	Confirm final mounting height on site
5I-1	FE-5101 / FQIT-5101	Well Water Supply to Incubation Magnetic Flow Transmitter	24 VDC	0-500 gpm	N/A	GI-4	40 70 30	
5I-1	FE-5102 / FQIT-5102	Reuse Water Supply to Incubation Magnetic Flow Transmitter	24 VDC	0-800 gpm	N/A	GI-4	40 70 30	
5I-2	LSHH-5203	Incubation Reuse Pump Station High High Level Switch	24 VDC	On/Off	EL 46.00	GI-6/GI-12	40 70 30	Confirm final mounting height on site
5I-2	LE-203 / LIT-5203	Incubation Reuse Pump Station Radar Level Transmitter	24 VDC	0-15 ft	N/A	GI-7 /GI-12	40 70 30	Confirm final mounting height on site
5I-2	LE-5205 / LIT-5205	Formalin Metering Tank Radar Level Transmitter	24 VDC	0-15 ft	N/A	GI-7	40 70 30	Confirm final mounting height on site
5I-2	LSHH-5205	Formalin Metering Tank High High Level Switch	24 VDC	On/Off	EL 45.83	GI-6/GI-12	40 70 30	Confirm final mounting height on site
5I-2	PI-5204 / PIT-5204	Formalin Metering Pump Discharge Pressure Transmitter	24 VDC	0-100 psi	N/A	GI-8/GI-12	40 70 30	
5I-2	FE-5404 / FQIT-5404	Formalin Metering Pump Discharge Magnetic Flow Transmitter	24 VDC	0-10 gpm	3 gpm	GI-4	40 70 30	
5I-4	TI-5404 / TIT-5404	Incubation Chiller System Temperature Transmitter	24 VDC	0-100 deg F	40 deg F	GI-9	40 70 30	Or 10 deg F less than AE-2101
5I-2	PI-5402 / PIT-5402	Screen Filter Inlet Pressure Transmitter	24 VDC	0-100 psi	N/A	GI-8/GI-12	40 70 30	
5I-5	SOV-5501	Utility Water Connection to Formalin Solenoid Valve	120 VAC	On/Off	N/A	N/A	40 70 30	
5I-5	PI-5501	Utility Booster Pump Pressure Gauge	N/A	0-20 psi	N/A	GI-8	40 70 30	
6I-1	FQIT-6101	Rearing Tank T-601 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6102	Rearing Tank T-602 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6103	Rearing Tank T-603 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6104	Rearing Tank T-604 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6105	Rearing Tank T-605 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6106	Rearing Tank T-606 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6107	Rearing Tank T-607 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-1	FQIT-6108	Rearing Tank T-608 Clamp-On Flow Transmitter	120VAC	0-600 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6111	Early Rearing Trough ERT-1 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6112	Early Rearing Trough ERT-2 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6113	Early Rearing Trough ERT-3 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6114	Early Rearing Trough ERT-4 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6115	Early Rearing Trough ERT-5 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6116	Early Rearing Trough ERT-6 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6117	Early Rearing Trough ERT-7 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6118	Early Rearing Trough ERT-8 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6119	Early Rearing Trough ERT-9 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	
6I-2	FQIT-6120	Early Rearing Trough ERT-10 Clamp-On Flow Transmitter	120VAC	0-100 gpm	N/A	GI-5	40 70 30	

6I-2	FQIT-6120	Early Rearing Trough ERT-10 Clamp-On Flow Transmitter	120VAC		N/A	GI-5	40 70 30	

SECTION 40 91 00 - SCADA SYSTEMS AND EQUIPMENT

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide Programmable Logic (PLC), Human Machaine Interface (HMI), and supervisory control and data acquisition (SCADA) system equipment, support, and programming, Work under this contract shall include the following:

1. Provide (3) three Local Control Panels (LCPs):

   a. Area 6 - Rearing Tanks (LCP-600)

   b. Area 4 – Water Treatment and Storage (LCP-400)

   c. Area 3 – Pumped Intake (LCP-300)

2. Provide (1) one Master Control Panel:

   a. Area 5 – Incubation Building (MCP-01)

3. Connect all new instruments and devices to the Master and Local Control Panels.

4. Connect all vendor hardwire and communications cables to Local and Master Control Panels.

5. Connect between panels using armored fiber cables pulled through new conduit.

6. Procure and install ethernet or other cables to bring all signals and alarms back to the main hatchery panel.

7. Program main hatchery panel to integrate all signals and alarms into the current hatchery monitoring system.

8. Fabricate panels in accordance with these specifications and the contract drawings.

   a. Control panels to be fabricated based on the general arrangement and layout found on GE-17,18,19,20.

   b. Programming of control panels based on the I/O lists found GI-13,14,15,16.

B. Responsibilities

1. The CONTRACTOR, through the use of a single System Integrator and qualified electrical and mechanical installers, shall be responsible to the OWNER for the implementation of the PLC, HMI, and SCADA system and the integration with instrumentation and control devices and vendor systems.

2. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these specifications that the System Integrator will be responsible to the CONTRACTOR for the integration of the PLC,HMI, and SCADA system with all devices provided under this and other Divisions with the objective of providing a completely integrated control system free of signal incompatibilities.

3. The CONTRACTOR shall request the OWNER to demonstrate that all existing equipment that is to be reused or interfaced with in this project works properly for the intended function. In the event the existing equipment does not work, the issue should be brought up in preconstruction/ pre-submittal meeting(s).

4. As a minimum, the implementation of the SCADA system upgrades by the CONTRACTOR shall include the following WORK:

    a. Programming of PLC's for Local and Master Control Panels.

    b. Programming of HMI's.

    c. Providing all PLC, HMI, and SCADA software.

    d. Providing all PLC, HMI, and SCADA hardware.

        1) CONTRACTOR to engage the OWNER for preferred SCADA software and hardware equipment and base the bid pricing on that. Hardware and software shall be based on the ones found on the OWNERs other hatchery locations.

    e. Integrate the devices and systems provided under this and other Divisions with the existing hatchery SCADA system.

    f. Prepare the required submittals.

    g. Design and develop project-wide loop/schematic diagrams including those associated with equipment provided under other Divisions and Owner-furnished and existing equipment

    h. Design and develop control panel drawings.

    i. Field verify existing conditions.

    j. Procure hardware and software.

    k. Configure and factory test the equipment.

    l. Integrate with vendor control systems (ie, screen systesm, drum filters, UV, chiller, pumps, etc.).

    m. Verify instrument calibration after installation.

    n. Terminate signals inside control and network panels; terminate communication and network devices and nodes.

    o. Coordinate installation and termination of field signals, power, and utilities associated with the PLCs. Resolve signal, power, or functional incompatibilities between interfacing devices.

    p. Oversee, document, and certify system commissioning including setpoints.

    q. Prepare technical manuals.

    r. Develop HMI screens.

s. Develop SCADA screens.

t. Prepare SCADA system as-built final construction drawings.

C. RELATED WORK AND REQUIREMENTS SPECIFIED ELSEWHERE

1. All electrical work required under this section shall conform to the requirements of this Section and the applicable requirements of the Sections in Division 01 and Division 26.

1.2 DEFINITIONS

A. System Integrator**:** The System Integrator shall be a single firm, corporation, or other entity assuming full responsibility through the CONTRACTOR to perform all engineering and to select, furnish, program, configure, integrate, supervise the installation and connections, test, calibrate, and place into operation all instrumentation, controls, communication hardware and software. The System Supplier shall specialize and have an experienced engineering and technical staff in the design, integration, and supply of systems similar to the one in these Contract Documents.

1. Acceptable System Integrators, or approved equal:

a. PumpTech Integration (formerly L2 Systems, LLC). (Contact: Glen Lee 360-386-9675, glen.lee@l2systemsllc.com)

1.3 ACTION SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00 - Submittal Procedures and the requirements below. The CONTRACTOR shall coordinate the SCADA system part of the WORK so that a complete instrumentation and control system will be provided and will be supported by accurate Shop Drawings and as-built drawings. Interface between instruments, flowmeters and other equipment related to the SCADA system shall be included in the shop drawing submittal. Interface between existing equipment, instruments and control panels shall also be included.

B. Shop Drawings: Provide shop drawings showing interfaces between new and existing instruments, flow meters, panels, and other equipment related to the SCADA system.

C. System Hardware: Provide a technical data sheet or brochure for each hardware component.

D. System Software: Submit vendor documentation including description of the standard (baseline) application Human Machine Interface (HMI) software programs, operating system and utility programs to be furnished. In addition, provide control narratives which describe all monitoring and control functions in the PLC.

E. Input and Output (I/O) Data List: Provide I/O data base listing for each data point relevant parameters such as range, active state, contact orientation, limits, incremental limits, and I/O hardware address.

F. Panel Drawings: Provide panel drawings for each new panel.

G. Technical Manual: Provide technical manuals for all furnished equipment.

1.4 WARRANTY

A. Parts and materials shall be warranted for defects for a period of 1-year after the date of installation.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Standard and Current Technology: All PLC, HMI, and SCADA system hardware, software, materials, and equipment furnished under this contract shall be new, free from defects, and shall be standard products and technology produced by manufacturers regularly engaged in the manufacturer of these products. Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

B. Confirm all PLC, HMI, and SCADA hardware and software with the OWNER's standards.

C. Instrument and Loop Power: Power requirements and input/output connections for components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. Power supplies shall be mounted within control panels or in the field at the point of application.

D. Loop Isolators and Converters: The CONTRACTOR is responsible to resolve any signal level incompatibilities where required.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. All PLC, HMI, SCADA systems and instrumentation, including instrumentation furnished under other Divisions, shall be installed, connected calibrated, tested, started, and placed into operation in accordance with CONTRACT documents under and the manufacturers' instructions. The installation shall be coordinated with the ENGINEER . This shall include final integration in concert with equipment specified and provided by others.

2. The CONTRACTOR shall employ installers who are skilled and experienced in the installation and connection of all equipment.

3. The CONTRACTOR shall review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

4. The Contract Documents identify conduits and instruments required to make a complete control system. The CONTRACTOR shall be responsible for providing any reasonable additional or different type connections as required by parts of the PLC, HMI, and SCADA system specific installation requirements, or as practical.

B. Installation and Connections:

1. Instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements applicable to the Site. Appropriate mounting stands and bracket materials and workmanship shall be provided and shall comply with requirements of the Contract Documents.

2. Wires and cables shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. Wiring shall be protected from sharp edges and corners.

3. Connectors shall be, as a minimum, water tight where below grade.

3.2 COMMISSIONING

A. Commissioning is the verification that the complete WORK functions on an extended basis are in full conformance with the Contract requirements. Provide commissioning of the PLC, HMI, and SCADA system and equipment that demonstrates continuous successful function for a period of at least 7 days.

END OF SECTION

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SECTION 42 51 00 – CHILLER SYSTEM

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide a packaged chiller system, and all appurtenant work, complete and operable, in accordance with the Contract Documents. All WORK shall be performed in accordance with the applicable codes and regulations.

B. The requirements of Section 46 01 00 – Equipment General Provisions, apply to the WORK of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:

1. ARI/AHRI 550/590
2. American National Standards Institute (ANSI)/ASHRAE 15.
3. American Society of Mechanical Engineers (ASME) Section VIII.
4. ANSI UL 1995
5. AHRI
6. NEC

1.3 SUPPLIER QUALIFICATIONS

A. The chiller system manufacturer / distributor shall have a minimum of 5 years experience in design, manufacturing, and installation of water-chilling systems at fish hatcheries. Upon request, the chiller system manufacturer shall supply no less than 5 references including company name and contact information.

1.4 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Division 1.

B. Shop Drawings

1. Dimensional drawings showing, at minimum, the following:
   a. Equipment dimensions including minimum recommended clearances;
   b. Location of all field piping and electrical connections;
   c. Materials of construction;
   d. Arrangement of equipment internals;
   e. Leveling and anchoring requirements and calculations;
   f. Control panel size and layout;

g. Wiring schematic.

C. Electrical and water quality requirements during operation, standby and shutdown.

D. Product information or catalog cuts for buyout components.

E. Technical Manuals.

F. Certificate or letter of confirmation of equipment warranty.

G. As-built Drawings

1.5 QUALITY ASSURANCE

A. Unit shall be rated in accordance with AHRI (Air- Conditioning, Heating and Refrigeration Institute) Standard 550/590, latest edition (U.S.A.) and all units shall be ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) 90.1 compliant.

B. Unit construction shall comply with ASHRAE 15 Safety Code, UL latest edition, and ASME (American Society of Mechanical Engineers) applicable codes.

C. Unit shall be full load run tested at the factory.

D. Packaged chiller shall be delivered to the job site and charged with refrigerant.

E. Third-party vendors and CONTRACTOR shall comply with manufacturer's instructions for transporting and rigging.

1.6 WARRANTY

A. The MANUFACTURER shall provide warranty for all equipment for a period of 12 months from successful completion of pre-commissioning tests.

B. During the warranty period, the MANUFACTURER shall replace or repair non-consumable parts proved to be defective in material or workmanship upon written notice, provided that the equipment is installed in accordance with the manufacturer's instructions and operated and maintained in accordance with the instructions contained in the MANUFACTURER's Technical Manual.

C. The MANUFACTURER shall be liable for the direct labor and material costs of repairs or replacement performed by the OWNER during the warranty period, but only if the MANUFACTURER gives prior authorization in writing for the repair or replacement involved.

PART 2 -- PRODUCTS

2.1 SYSTEM REQUIREMENTS

A. Identification

Equipment Number	CHS–500
Quantity	1
Location	Incubation Building (Indoors)

B. Product Description

Equipment Type	Water cooled, flooded, stainless steel chiller package system with Caryle semi-hermetic suction cooled compressors with automatic oil return system.
Condenser Type	Water Cooled
Compressor Type	Reciprocating with two stages of electric capacity control.
Internal Refrigerant Type	R-513a
Power Supply	Single point connection - 480 V, 3 Ph, 60 Hz

C. Chiller Operating Conditions

Duty	Continuous during incubation
Drive	Variable Speed
Ambient Environment	Inside building enclosure
Ambient Temperature	60 – 75 deg F
Fluid Service	Groundwater
Fluid pH Range	6 to 8

D. General Design Conditions

Chilled Water Flow Rate	80 gpm
Chilled Water Inlet Temperature	50 deg F
Chilled Water Exit Temperature	38 deg F

Chilled Water Inlet Pressure	Approx. 1-2 psi
Chilled Water Outlet Pressure	10 psi (9'-10" above finished floor elev.)
Chilled Water Pump Quantity	2 (1 duty and 1 shelf spare)
Compressor Quantity	2 (redundancy)
Condenser Cooling Water Inlet Temperature	50 deg F
Condenser Cooling Water Exit Temperature	per MFR
Evaporator Tube Material	Stainless Steel
Condenser Tube Material	Marine duty – CUNI (copper-nickel alloy)
Chilled Water Storage Tank	Minimum 300 gallons storage capacity. Insulated to a minimum R-8. Appropriately sized flywheel loop piping may be used in lieu of a storage tank.

2.2 CHILLER COMPONENTS CHARACTERISTICS

A. All chiller components shall be factory assembled as one single piece integral unit capable of meeting the system requirements. Chiller shall be cleanable, flooded style with stainless steel tubes and surge drum to ensure vapor return to compressor(s).

B. CONTRACTOR shall be responsible for field piping, fittings, appurtenances, supports that connect to the chiller/condenser unit.

C. Piping, fittings, appurtenances, supports located on the chiller/condenser skid shall be the responsibility of the selected chiller/condenser manufacturer.

D. Compressors

1. Compressor shall be Carlyle semi-hermetic suction cooled design with automatic oil return.

2. The compressor shall be capable of coming to a controlled stop in the event of a power failure. The unit shall be capable of initializing an automatic restart in the case of power failure.

3. The compressor shall have integrated microprocessor control capable of capacity and safety control.

E. Evaporator

1. Evaporator shall be shell-and-tube type.

2. Heat exchangers shall be designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII Code Case 1518-5. They shall have a copper wall of 0.025 in. wall thickness.

3. In the evaporator, refrigerant shall be in the shell and water inside the tubes.

4. The water sides shall be designed for a minimum of 145 psig.

5. The water connections for the evaporator and condenser shall be flanged.

6. Vents and drains shall be provided.

7. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VII. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 100 psig.

8. Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports.

9. The evaporator shall be provided with spring loaded reseating-type pressure relief valves according to ASHRAE-15. Rupture disks are not acceptable.

10. A perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing to assure effective liquid droplet removal to prevent liquid damage to compressor.

11. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

F. Condenser

1. Condenser shall be shell-and-tube type.

2. Condenser shall be marine grade service.

3. Heat exchangers shall be designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII Code Case 1518-5.

4. In the condenser, refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 145 psig.

5. The water connections for the condenser shall be marine duty.

6. Provide condenser pump(s) to boost pressure to system requirements.

7. Vents and drains shall be provided.

8. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VII. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 100 psig.

9. Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports.

10. The condenser shall be provided with dual relief valves equipped with a transfer valve so one valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the vessel. Rupture disks are not acceptable.

11. Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves.

G. Liquid Level Control

1. A Level Master or High Side float shall be used as the refrigerant metering device.

H. Drive

1. Permanent-magnet, synchronous hermetically sealed motor of sufficient size to effectively provide compressor horsepower requirements. Motor shall include soft-start capabilities.

2. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.

3. Compressor motor and chiller unit shall include variable-frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.

4. The compressor shall be equipped with an AC line reactor and individual disconnect.

I. Chiller Controls

1. The chiller shall be controlled by a Watlow, PRO temperature controller, or equal. The compressor capacity control shall utilize staged up/down depending on leaving water temperature of the chiller. Compressors shall include individual pressure and current safeties. The status of the compressors and all system parameters including compressor alarms and temperature and runtime trends shall be an output and available for integration into the facilities SCADA system.

2. Controller features must include the following:

a. Selectable control mode –leaving chilled water temperature.

b. Continuous data logging of inlet and outlet chilled water temperature, run time, and run status for operational trending and bin analysis shall be exportable to “CSV” format. (12 months data stored).

c. Data on Main Display Screen shall include:

1) Entering and leaving chilled water temperatures.

2) Entering and leaving condenser water temperatures.

3) Current operating state of chiller.

4) Active system run-time timers.

5) Chiller set point.

6) Current alarms.

d. The following outputs for SCADA system integration shall include:

1) Entering chilled water temperatures.

2) Leaving chilled water temperatures.

3) System status and run time.

2.3 TOOLS AND SPARE PARTS

A. For any special tools unique to the chiller system, two sets of those tools shall be provided.

B. Provide a shelf spare chilled water pump.

2.4 MANUFACTURERS OR PRE-APPROVED EQUAL

A. Raincountry Refrigeration, Inc., Bellingham, WA

PART 3 -- EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Unit controls shall be capable of withstanding 150 F storage temperatures in the control compartment.

B. Unit shall be stored and handled per unit manufacturer's recommendations.

3.2 INSTALLATION

A. Installation shall be per the manufacturer's recommendations and as indicated.

B. Adjust and level package unit in alignment on supports.

C. Arrange piping to enable dismantling and permit head removal for tube cleaning.

D. Coordinate electrical installation with Electrical Contractor.

E. Coordinate controls with Controls Contractor.

F. Verify piping and electrical connections are complete and in accordance with chilling manufacturer’s requirements.

G. Provide anchoring for chiller units per manufacturer’s recommendations, the requirements of the structural drawings and Specifications.

H. START-UP SUPERVISION

I. Provide authorized factory service technicians from the equipment manufacturer/supplier for starting, field adjustment, testing of the chiller system and chiller operating instruction to the OWNER.

J. Unit shall be field charged with HFC-134a refrigerant.

K. The system shall be test run for a minimum of 48 continuous hours prior to acceptance.

3.3 OWNER STAFF TRAINING

A. Provide owner staff training for the packaged chiller system in accordance with the requirements of Section 46 01 00 – Equipment General Provisions.

END OF SECTION

SECTION 43 20 00 - PUMPS, GENERAL

PART 1 - GENERAL

1.1 THE SUMMARY

A. Provide pumps and pumping appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.

C. The requirements of Section 46 01 00 – Equipment General Provisions, apply to this Section.

D. Unit Responsibility

1. The pump manufacturer shall be made responsible for furnishing the pumps, motors, and VFDs as one package and for the coordination of design, assembly, testing, and installation of the WORK of each specific pump Section.

2. The CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each specific pump Section.

E. Single Manufacturer

1. Where 2 or more pump systems of the same type or size are required, provide pumps produced by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Shop Drawings

1. Submit pump name, identification number, and specification Section number.

2. Performance Information:

a. Submit performance data curves showing head, capacity, horsepower demand, NPSHr3 required, and pump efficiency over the entire operating range of the pumps. Submit efficiency curves of motors and VFDs.

b. Require the equipment manufacturer to indicate the head, capacity, required horsepower, pump efficiency, and NPSHr corresponding to each flow condition indicated in the respective performance requirement paragraph of each individual pump specification section. Indicate on the pump curve the Allowable Operating Region (AOR), Preferred Operation Region (POR), and minimum submergence required at maximum flow for vertical and submersible pumps.

c. Submit performance curves at intervals no greater than 100 RPM from the specified minimum speed to maximum speed for each centrifugal pump equipped with a variable speed drive.

3. Operating Range - The performance curves shall indicate the manufacturer-recommended limits for stable operation without surge, cavitation, or excessive vibration.

4. Submit assembly and installation drawings, including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

5. Submit data, in accordance with the requirements of Section 26 05 10 – Electric Motors, for the electric motor proposed for each pump.

6. Submit an elevation drawing of the proposed local control panel, showing panel-mounted devices, details of enclosure type, a single-line diagram of power distribution, current draw of the panel, and a list of terminals required to receive inputs or to transmit outputs from the local control panel.

7. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items.

8. Technical Manual

    a. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

9. Spare Parts List

    a. Submit a spare parts list containing the required information indicated in Section 01 33 00 – Contractor Submittals and each specific pump Section.

10. Certifications

    a. Submit the manufacturer's certification of proper installation.

    b. Submit the CONTRACTOR's certification of satisfactory field testing.

PART 2 - PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Compatibility

1. Provide entirely compatible components of each pump system provided under the specific pump Sections.

2. In each unit of pumping equipment, incorporate basic mechanisms, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

2.2 MATERIALS

A. Provide materials suitable for the intended application.

B. For materials not indicated, provide high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:

2.3 PUMP COMPONENTS - GENERAL

A. Flanges and Bolts

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Pressure class shall be suitable for the application or as otherwise recommended by the pump manufacturer.

2. Provide flange bolts in accordance with the requirements of Section 40 05 00 – Piping, General.

3. Flange gaskets shall be in accordance with Section 40 05 00 - Piping, General

2.4 PUMP APPURTENANCES

A. Nameplates

1. Equip each pump with a stainless steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Gauges

1. Except for sample pumps, sump pumps, and hot water circulating pumps, equip pumps with pressure gauges installed at the pump discharge lines.

2. Provide pressure and compound gauges in accordance with the requirements of Section 40 91 08 – Pressure Measuring.

2.5 FACTORY TESTING

A. Conduct the following tests on each indicated pump system:

1. Motors

a. Test electric motors in accordance with the requirements of Section 26 05 10 – Electric Motors.

b. Furnish test results to the pump manufacturer prior to the pump test.

2. Variable Frequency Drives

a. Test variable frequency drives in accordance with the requirements of Division 26 – Variable Speed Drives section.

b. Furnish test results to the pump manufacturer prior to the pump test.

3. Certified Factory Non-witnessed Test

a. Perform factory non-witnessed tests on centrifugal pumps with drives up to and including 125 hp in accordance with the ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Test.

b. For pumps with drives smaller than 15 hp, sump pumps, and sample pumps, pumps shall meet hydraulic acceptance criteria Grade "2U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

   1) Hydrostatic test;

   2) Performance test at guaranteed design point or duty point documenting head, flow, bhp, and efficiency results.

   3) Unless otherwise indicated, it is not required to test NPSHr in the factory. Instead, manufacturer shall submit the published NPSHr curve in accordance with the requirements of this specification section.

   4) Additional tests as indicated in the specific pump specification sections.

c. For pumps with drives 15 hp and larger shall meet hydraulic acceptance criteria Grade "1U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

   1) Hydrostatic test;

   2) Performance Test:

      a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute Standards;

      b) For variable speed driven pumps, test each pump between maximum and minimum speed at intervals no greater than 100 RPM;

      c) Submit pump curves showing head, flow, bhp, NPSHr and efficiency results. The manufacturer's certification shall be visible on each submitted curve;

   3) Mechanical testing shall be limited to observation during the hydraulic performance test for any abnormal bearing temperature and pump vibration. Any deficiencies shall be corrected by the manufacturer.

   4) NPSHr3

      a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.

      b) Acceptance criteria shall be in accordance with ANSI/HI 14.6

      c) If not required by the specific pump Section, submit the published manufacturer-calculated NPSHr3 curve.

   5) Additional tests as indicated in the specific pump specification sections.

d. Perform tests using the completely assembled project pump, motor, and VFD system (if equipped with variable speed drive). Calibrated factory motor may be used in lieu of project motor subject to approval of the ENGINEER.

e. Where multiple pumps are required in the project, one project variable speed drive and motor of each size shall be used for testing pumps as completely assembled systems.

f. Testing of prototype models will not be accepted.

g. Submit certification signed by a senior official of the pump manufacturer that the required pump shaft horsepower did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

h. No equipment shall be shipped until the test data have been approved by the ENGINEER.

4. Certified Factory Witnessed Tests

a. Perform factory witnessed tests on centrifugal pumps with drives 150 hp and larger in accordance with the certified factory non-witnessed test procedure indicated above for 15 hp to 125 hp pumps with the exception that the tests shall be witnessed by the OWNER and ENGINEER. Where multiple pumps is required in the project, one project variable speed drive and motor of each size shall be used for testing pumps as completely assembled systems.

b. Mechanical tests shall be conducted in accordance with ANSI/HI 14.6, Appendix E, Mechanical Test. Such tests shall, at a minimum, consist of the following;

1) Measure and record overall motor winding temperature

2) Measure and record motor and pump bearing temperatures.

3) Measure and record motor and pump vibration.

4) Acceptance criteria and mechanical test records shall be in accordance with ANSI/HI 14.6, Appendix E, Mechanical Test.

c. The CONTRACTOR shall provide the OWNER and ENGINEER a minimum of 2 weeks notification prior to the test.

d. Excluding salaries, costs for the attendances of one representative for the OWNER and one representative for the ENGINEER shall be borne by the CONTRACTOR and shall be included in the Contract Price, including travel and subsistence costs. The cost shall include repetitive visits, if required. If additional witnessed testing is required due to failure of the pumps to meet specified conditions, expenses of the ENGINEER and OWNER shall be covered by the CONTRACTOR.

e. No equipment shall be shipped until the test data have been approved by the ENGINEER.

5. Acceptance

a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

PART 3 - EXECUTION

3.1 MANUFACTURER'S SERVICES

A. Inspection, Startup, and Field Adjustment

1. Where required by the specific pump Section, furnish an authorized service representative of the manufacturer at the Site continuously to supervise the following items and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

a. Installation of the equipment;

b. Inspection, checking, and adjusting the equipment;

c. Startup and field testing for proper operation; and

d. Performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements.

B. Instruction of OWNER's Personnel

1. Where required by the individual pump Section, furnish an authorized training representative of the manufacturer at the Site for the number of Days indicated in the specific pump Section, to instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

3.2 INSTALLATION

A. General

1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

1. Field-test the equipment in order to verify proper alignment and freedom from binding, scraping, shaft run out, or other defects.

2. Ensure that the equipment is secure in position and neat in appearance.

C. Lubricants

1. Provide the necessary oil and grease for initial operation.

3.3 PROTECTIVE COATING

A. Coat materials and equipment in accordance with the requirements of Section 09 96 00 – Protective Coating.

3.4 FIELD TESTS

A. Field-test each pump system after installation simulating all of the operational scenarios as specified in order to demonstrate:

1. Satisfactory operation without excessive noise and vibration;

2. No material loss caused by cavitation;

3. No overheating of bearings; and,

B. Conduct the following field testing:

1. Startup, check, and operate the pump system over its entire speed range.

2. If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

3. If the pump is driven by constant speed, test the pump and motor at the maximum RPM.

4. Check each power lead to the motor for proper current balance.

5. Bearing Temperatures

a. Determine bearing temperatures by a contact-type thermometer.

b. Precede this test with a run time sufficient to stabilize bearing temperatures, unless an insufficient liquid volume is available to furnish such a run time.

6. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

C. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

D. The CONTRACTOR shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the OWNER will bear.

E. If available, the OWNER'S operating personnel will provide assistance in field testing.

END OF SECTION

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SECTION 43 25 05 - SUBMERSIBLE SUMP PUMPS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide submersible sump pumps and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 20 00 - Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 20 00 – Pumps, General and Section 01 33 00 – Contractor Submittals.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification:

P-301	Surface Water Intake Pump 1
P-302	Surface Water Intake Pump 2
P-303	Surface Water Intake Pump 3
P-530	Incubation Reuse Pump 1
P-531	Incubation Reuse Pump 2
P-540	Formalin Metering Tank Pump 1

B. Operating Conditions: The WORK of this Section shall be suitable for long term operation under the conditions:

Duty	Intermittent
Drive	Variable Frequency
Ambient environment	Outdoor sump
Fluid service	Water
Fluid temperature, degrees F	40 to 70
Fluid pH range	6 to 8

Project site elevation, ft. a.s.l	52
Minimum available NPSH, ft absolute	34
Maximum dia. of spheres to pass, in.	0.5

C. Performance Requirements (P-301/302/303):

Design flow capacity, gpm	2400
Design flow pump head, TDH ft	75
Design flow minimum pump efficiency, percent	80
Maximum motor size, hp	60
Motor Volts/Phases/Hz	480/3/60

Performance Requirements (P-530/531):

Design flow capacity, gpm	440
Design flow pump head, TDH ft	80
Design flow minimum pump efficiency, percent	70
Maximum motor size, hp	5
Motor Volts/Phases/Hz	480/3/60

Performance Requirements (P-540):

Design flow capacity, gpm	6
Design flow pump head, TDH ft	15
Design flow minimum pump efficiency, percent	70
Maximum motor size, hp	1/3
Motor Volts/Phases/Hz	480/3/60

2.2 PUMP REQUIREMENTS

A. Construction: Construction of submersible sump pumps shall conform to the following requirements:

Pump casing	Polypropylene or Cast iron
Impeller	Semi-open or closed, non-clog
Bearings	Permanently lubricated ball and sleeve type
Shaft	Stainless steel, series 400
Seal	Mechanical seal
Mounting Method	stainless steel chain and hook
Check Valve	Integral with pump
Pump Connection	threaded with neoprene pressure hose

B. Drive: Enclosed, submerged, electric motor, suitable for 480 volt, three phase, 60 Hz ac power supply.

C. Coating: Provide manufacturer's standard coating

2.3 PUMP CONTROLS

A. Pumps shall be equipped with integral float switches for controlling pump start and stop. A separate high level float switch for the sump shall be furnished as part of, and as specified under, Division 40.

B. Each pump shall be supplied with a vendor-supplied control panel (VCP) and shall house all required controls, circuit breakers, motor starters, and contacts. The VCP shall have a HAND/OFF/AUTO hand switch to permit local operation of each pump, and indicator lights for RUN status and FAIL status. The VCP shall have dry contacts to provide remote monitoring via OWNER's PLC of all status signals as shown on the Contract Documents, which shall include at a minimum RUN status and FAIL status.

2.4 MANUFACTURERS, OR EQUAL

A. **Ebara Pumps Americas Corporation**

B. **KSB**

C. **Flygt Corporation**

D. **Goulds Pumps Inc.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. General installation requirements shall be in accordance with Section 43 20 00 - Pumps, General.

END OF SECTION

SECTION 43 30 00 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide valves, actuators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 46 01 00 – Equipment General Provisions, apply to the WORK of this Section.

C. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated.

D. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls, as indicated.

E. Support

1. Where a valve is to be supported by means other than the piping to which it is attached, obtain from the valve manufacturer a design for its support and foundation that satisfies the criteria in Section 46 01 00 – Equipment General Provisions.

2. Submit the support design, including drawings and calculations sealed by an engineer, with the Shop Drawings.

F. Unit Responsibility

1. The CONTRACTOR shall assign a single manufacturer to be responsible for the supply, coordination of design, assembly, testing, and furnishing of each valve; however, the CONTRACTOR shall be responsible to the OWNER for compliance with the requirements of each valve Section.

G. Single Manufacturer

1. Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

B. Furnish the following information on Shop Drawings:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number;

2. Complete information on the valve actuator, hydraulic power units (HPU), pneumatic air supply system including size, manufacturer, model number, limit switches, and mounting;

3. Cavitation limits for control valves;

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems;

5. Complete wiring diagrams and control system schematics; and,

6. A valve-labeling schedule, listing the valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

C. Furnish a technical manual containing the required information for each valve, as indicated.

D. Furnish a spare parts list, containing the required information for each valve assembly, as indicated.

E. Factory Test Data

1. Where indicated, submit signed, dated, and certified factory test data for each valve requiring certification, before shipping the valve.

2. Furnish a certification of quality and test results for factory-applied coatings.

F. Field Test Data

1. Submit signed, dated, and certified field test data for each valve.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. General

1. Provide valves and gates of new and current manufacture.

2. Provide valves 6-inch and larger with actuators with position indicators.

3. Unless otherwise indicated, provide valve actuators in accordance with Section 43 30 12 – Valve and Gate Actuators.

B. Protective Coating

1. Coat the exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 2-inch and larger in accordance with the requirements of Section 09 96 00 – Protective Coating.

2. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with the indicated requirements.

3. Do not coat the machined flange faces of valves except where such flanges are not adjoining a mating flange as shown in the Contract Documents. Apply rust inhibitor coating on machined surfaces of the flange prior to shipment.

C. Valve Labeling

1. Except when such requirement is waived by the ENGINEER in writing, provide a label on shut-off valves and control valves except for hose bibbs.

2. Furnish a label composed of 1/16-inch plastic or stainless steel, a minimum of 2 inches by 4 inches in size, as indicated in Section 43 10 51 – Piping Identification Systems, and permanently attached to the valve or on the wall adjacent to the valve as directed by the ENGINEER.

D. Valve Testing

1. As a minimum, unless otherwise indicated or recommended by the reference standards, test valves 3 inches in diameter and smaller in accordance with the manufacturer's standard procedure.

2. Factory-test valves 4 inches in diameter and larger as follows:

a. Hydrostatic Testing

1) Subject valve bodies to an internal hydrostatic pressure equivalent to twice the water-rated pressure of the valve.

2) Metallic valves rating pressures shall be based at 100 degrees F.

3) Plastic valves rating pressures shall be based at 73 degrees F, or at a higher temperature according to material type.

4) During the hydrostatic test, there shall be no visible leakage through the valve body, end joints, or shaft seals, nor shall parts of the valve be permanently deformed.

5) Allow test duration of at least 10 minutes, in order to allow visual examination for leakage.

b. Seat Testing

1) Test the valves for leaks in the closed position, with the pressure differential across the seat equal to the water rated pressure of the valve.

2) Provide test duration of at least 10 minutes, in order to allow visual examination for leakage.

3) The leakage rate shall be the more stringent of the following:

a) As recommended by the reference standard for that type of valve; or

b) Leakage past the closed valve not to exceed one fluid ounce per hour per inch diameter for metal seated valves, and drop-tight for resilient seated valves.

c. Performance Testing

1) Shop-operate the valves from the fully-closed to the fully-open position, and reverse under no-flow conditions in order to demonstrate that the valve assembly operates properly.

E. Certification

1. Prior to shipment of valves with sizes larger than 12-inches in diameter, submit certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. Valve Markings

1. Permanently mark valve bodies in accordance with MSS SP25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General

1. Provide materials suitable for the intended application.

2. Provide materials in contact with potable water listed as compliant with NSF Standard 61.

3. Ensure that materials not indicated are of high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Unless otherwise indicated, provide valve and actuator bodies conforming to the following requirements:

a. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings

b. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

c. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service

d. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications. Bronze materials in contact with potable water service shall be free of lead content meeting the Lead Reduction Act.

e. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel

f. PVC: Polyvinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454

g. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447

h. NSF Standard 61: Materials shall be listed for use in contact with potable water.

i. Elastomeric materials used for seat, seals and O-rings shall be compatible with temperature, pressures and fluid or gas service.

1) Elastomeric materials for water with chloramines shall be Teflon or Viton-A.

2) Elastomeric materials for water with dissolved ozone residual shall be Teflon suitable for ozone service.

3) Elastomeric materials for oxygen (LOX or GOX) shall be Teflon specially manufactured and packaged suitable for oxygen service.

2.3 VALVE CONSTRUCTION

A. Bodies

1. Provide valve bodies that are cast, molded (in the case of plastic valves), forged, or welded, of the materials indicated, and with smooth interior passages.

2. Provide wall thicknesses uniform and in agreement with the applicable standards for each type of valve, without casting defects, pinholes, and other defects that could weaken the body.

3. Perform welds on welded bodies by certified welders and ground welds smooth.

4. Provide valve ends as indicated, and rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections

1. Unless otherwise indicated, valves 2-1/2 inches in diameter and smaller may be provided with threaded end connections.

2. Provide valves 3 inches in diameter and larger with flanged end connections.

3. Flanges, bolts and gaskets shall be as specified in Section 43 10 50 - Piping, General.

C. Bonnets

1. Connect valve bonnets to the body by clamping, screwing, or flanging.

2. Provide bonnets of the same material, temperature, and pressure rating as the body.

3. Make provisions for the stem seal with the necessary glands, packing nuts, and yokes.

D. Stems

1. Provide valve stems of the materials indicated, or, if not indicated, of the best commercially-available material for the specific service, with adjustable stem packing,

O-rings, chevron V-type packing, or other suitable seal. Bronze materials in contact with potable water shall be NSF 61 approved and free of lead. Elastomeric materials shall be compatible with fluid service.

E. Stem Guides

1. Provide stem guides spaced with an L/R ratio not to exceed 200:1. Submit calculations for L/R ratios and guide spacing to the ENGINEER for review.

2. Stem guides shall have slotted holes and shall be adjustable in two directions.

3. Construct submerged stem guides from Type 316 stainless steel.

F. Internal Parts

1. Provide internal parts and valve trim as indicated for each individual valve.

2. Where not indicated, construct valve trim from Type 316 stainless steel or other material best-suited for the intended service.

G. Nuts and Bolts

1. Unless otherwise indicated, provide nuts and bolts on valve flanges and supports in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork and Section 43 10 50 – Piping, General.

2.4 Torque Tubes

A. Submerged or buried valves with a remote gearbox and actuator shall be supplied with a torque tube to transfer torque from the actuator to the valve. Torque tubes shall be directly connected to the valve and the floor stand and gear actuator. Each torque tube and floor stand shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, torque tubes shall be made of schedule 40, steel pipe with epoxy coating suitable for the fluid service. Each submerged valve, torque tube, floor stand and actuator shall be pre-assembled and “matched marked” in the manufacturer’s shop to ensure proper fit when assembled in field.

2.5 Extension Shaft Stem

A. Valves mounted in dry areas with gearbox attached to the valve and with remote actuator shall be supplied with an extension shaft stem with universal joint attached to the gear and actuator. All components shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, shaft stem and universal joints shall be made of carbon steel with epoxy coating suitable for the fluid service. Each valve, shaft stem, floor stand and actuator shall be pre-assembled and “matched marked” in the manufacturer’s shop to ensure proper fit when assembled in field.

2.6 VALVE ACTUATORS

A. Valve actuators shall be as indicated and as specified in Section 43 30 12 – Valve and Gate Actuators

2.7 VALVE ACCESSORIES

A. Provide valves complete with the accessories required to provide a functional system.

2.8 SPARE PARTS

A. Furnish the required spare parts, suitably packaged and labeled with the valve name, location, and identification number.

B. Furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve.

C. Spare parts are intended for use by the OWNER, after expiration of the correction of defects period.

2.9 MANUFACTURERS

A. Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the indicated valves.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION AND TRIAL OPERATION

A. General

1. Install valves, actuating units, stem extensions, valve boxes, and accessories in accordance with the manufacturer's written instructions and as indicated.

2. Adequately brace gates in order to prevent warpage and bending under the intended use.

3. Firmly support valves in order to avoid undue stresses on the pipe.

B. Access

1. Install valves in a manner to provide easy access for actuation, removal, and maintenance, and to avoid interference between valve actuators and structural members, handrails, and other equipment.

C. Valve Accessories

1. Where combinations of valves, sensors, switches, and controls are indicated, properly assemble and install such items such that systems are compatible and operating properly.

2. Clearly note the relationship between interrelated items on Shop Drawing submittals.

D. Trial Operation

1. After installation, schedule trial operation witnessed by the ENGINEER and the OWNER representative.

2. All valves shall be cleaned thoroughly of all foreign materials and final adjustments made. The valves shall then be operated through one complete cycle from a fully closed position to a fully open position and back to a fully closed position to verify that the assembly is functional.

3. For control valves that operate in multiple operating scenarios, the CONTRACTOR shall simulate all operational scenarios including the hydraulic power units, pilot control system or pneumatic air supply system to demonstrate compliance to the specifications.

4. A field leakage test meeting the maximum allowable specified requirement shall be conducted.

5. Test certificate shall be signed by the valve manufacturer and the CONTRACTOR and shall be submitted to the ENGINEER.

END OF SECTION

SECTION 43 30 12 - VALVE AND GATE ACTUATORS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide valve and gate actuators and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility

1. Make the valve or gate manufacturer responsible for the coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the CONTRACTOR shall be responsible to the OWNER for compliance of the valves, gates, and actuators with the Contract Documents.

D. Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Section 26 05 15 – Industrial Control Panels apply to the WORK of this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals and Section 43 30 00 – Valves, General.

B. Submit Shop Drawing information for actuators with the valve and gate submittals as a complete package.

C. Submit calculations showing dynamic seating and unseating torques versus the output torque of the actuator.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual or power actuators.

B. Provide actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, hand wheels, levers, chains, and extensions, as applicable.

C. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering.

D. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves.

E. Identify wires of motor-driven actuators by unique numbers.

F. Manufacturers

1. Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer.

2. Where actuators are furnished by different manufacturers, coordinate the selection to result in the fewest number of manufacturers possible.

G. Materials

1. Provide actuators of current models, of the best commercial quality materials, and liberally sized for the required torque.

2. Provide materials suitable for the environment in which the valve or gate is to be installed.

H. Actuator Mounting and Position Indicators

1. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength.

2. Cast the word "OPEN" on each valve or actuator, with an arrow indicating the direction to open in the counter-clockwise direction.

3. Equip gear and power actuators with position indicators.

4. Where possible, locate manual actuators between 48 and 60 inches above the floor or the permanent working platform.

I. Standards

1. Unless otherwise indicated and where applicable, provide actuators in accordance with AWWA C 542 - Electric Motor Actuators for Valves and Slide Gates.

J. Provide fasteners in accordance with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

K. Provide coatings in accordance with the requirements of Section 09 96 00 – Protective Coating.

2.2 MANUAL ACTUATORS

A. General

1. Unless otherwise indicated, provide valves and gates with manual actuators.

2. Provide valves in sizes up to and including 4 inches with direct-acting lever or hand wheel actuators of the manufacturer's best standard design.

3. Provide valves and gates larger than 4-inch with gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the hand wheel.

4. Provide buried and submerged gear-assisted valves, gates, valves 30 inches in diameter and larger, and where indicated, with worm gear actuators, hermetically-sealed water-tight and grease-packed.

5. Valves 6-inch to 24-inch diameter may be provided with traveling-nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves

1. Unless otherwise indicated, provide buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.

2. Where indicated, provide buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size in order to allow operation of the valve actuators.

3. Permanently label the valve box covers as required by the local Utility Company or the ENGINEER.

4. Provide wrench-nuts in compliance with AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service.

C. Floor Boxes

1. Provide hot-dipped galvanized cast iron or steel floor boxes and covers to fit the slab thickness, for operating nuts in or below concrete slabs.

2. For operating nuts in the concrete slab, provide a bronze-bushed cover.

D. Tee Wrenches

1. Furnish buried valves with floor boxes with 2 operating keys or one key per 10 valves, whichever is greater.

2. Size the tee wrenches such that the tee handle will be 2 to 4 feet above ground, and to fit the operating nuts.

E. Manual Worm Gear Actuator

1. Provide an actuator consisting of a single- or double-reduction gear unit contained in a weatherproof cast iron or steel body with cover, and a minimum 12-inch diameter handwheel.

2. Provide the actuator to be capable of a 90-degree rotation, and equip the actuator with travel stops capable of limiting the valve opening and closing.

3. Provide the actuator with spur or helical gears and worm gearing.

4. Provide a self-locking gear ratio in order to prevent "back-driving."

5. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

6. Construct the worm gear shaft and the hand wheel shaft from 17-4 PH or similar stainless steel.

7. Accurately cut gearing with hobbing machines.

8. Use ball or roller bearings throughout.

9. Provide the output shaft end with a spline in order to allow adjustable alignment.

10. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator.

11. Design gearing for a 100 percent overload.

12. The entire gear assembly shall be sealed weatherproof.

F. Floor Stand Actuators

1. Provide floor stand actuators for gates and valves where indicated. Bodies shall be ductile iron. Handwheel shall be mounted to the top or side and shall include a padlock adapter. Where possible, provide an adapter to allow actuators to be be opened using an impact driver.

G. Design and rate buried gear actuators for buried service, provide with a stainless steel input shaft, and double-seal on shaft and top cap.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments

1. The adjustment of actuator controls and limit switches in the field for the required function shall be performed by field representatives of the manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators.

3.2 INSTALLATION

A. Install valve and gate actuators and accessories in accordance with the requirements of Section 43 30 00 – Valves, General.

B. Locate the actuators to be readily accessible for operation and maintenance without obstructing walkways.

C. Do not mount actuators where shock or vibrations will impair their operation, and do not attach the support systems to handrails, process piping, or mechanical equipment.

END OF SECTION

SECTION 43 30 14 - BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents. Where indicated, salvage and reinstall existing butterfly valves.

B. The requirements of Section 46 01 00 – Equipment General Provisions apply to this Section.

C. The requirements of Section 43 30 00 - Valves, General apply to this Section.

D. The requirements of Section 43 30 12 - Valve Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Dynamic seating and unseating torque for motor actuated valves.

4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

1.3 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 -- PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES 25 TO 150 PSI (AWWA)

A. General: Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for fresh water service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504 and be as indicated. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 24-inches shall be rated for Class 150B with actuator sized for Class 150B. Valves 30 inches through 72-inches shall be of the class indicated. Valves larger than 72-inches shall be of the class indicated, designed in accordance with the intent of AWWA C504. If the operating conditions such

as flow, velocity, and differential pressures are not indicated, the valve body and shaft shall be sized for the pressure class rating of the valve.

B. Valves shall be of the body type, pressure class, end joint, and actuator indicated.

C. Construction: Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	Material Standards
Valve bodies	Gray iron, ASTM A 48, Class 40 or Gray iron, ASTM A 126, Class B, or Ductile iron, ASTM A 536, grade 65-45-12 or 70-50-05
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A 240 or A 276, Type 316
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A 240 or A 276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self-lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	Refer to Section 09 96 00 – Protective Coating

D. Manual Actuators: Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.

E. Worm Gear Actuators: Buried valves shall be equipped with worm-gear actuators, lubricated and sealed to prevent entry of dirt or water into the housing.

F. Manufacturers, or Equal

1. **DeZURIK Water Controls, Corporation**
2. **Kennedy Valve**
3. **M & H Valve Company**

4. **Mueller Company**

5. **Henry Pratt Company**

6. **Rodney Hunt Company** (24-inches and larger)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 43 30 00 – Valves, General.

END OF SECTION

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SECTION 43 30 16 - CHECK VALVES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 - Valves, General apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General.

PART 2 -- PRODUCTS

2.1 SWING CHECK VALVES (3-INCHES AND LARGER)

A. General: Swing check valves for water, sewage, sludge, and general service shall be of the outside lever and spring or weight type, in accordance with AWWA C 508 - Swing-Check Valves for Waterworks Service, 2-in. through 24-in. NPS, unless otherwise indicated, with full-opening passages, designed for a water-working pressure of 150 psi. Units shall have a flanged cover piece to provide access to the disc. Where indicated, swing check valves shall be provided with position indicators.

B. Body: The valve body and cover shall be of cast iron conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with flanged ends conforming to ASME B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800, or be mechanical joint ends, as indicated.

C. Disc: The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 584 - Copper Alloy Sand Castings for General Applications.

D. Seat and Rings: The valve seat and rings shall be of bronze conforming to ASTM B 584 or B 148 - Aluminum-Bronze Castings or of Buna-N.

E. Hinge Pin: The hinge pin shall be of bronze or stainless steel.

F. Manufacturers, or Equal

1. **APCO (Valve and Primer Corp.)**
2. **Kennedy Valve**
3. **Mueller Company**
4. **Stockham Valves and Fittings**
5. **Golden Anderson**

2.2 FLANGED RUBBER CHECK VALVES

A. General: Rubber check valves shall be duckbill style and fully passive. Valves shall be of standard neoprene construction and designed to bolt directly to an ANSI 150# standard

flange of the size indicated. The valve shall have a low cracking pressure of no more than 3 inches of water head. Provide a stainless-steel retaining ring for connection to the flange.

B. Manufacturers, or Equal

1. Proco Style 710 ProFlex

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 43 30 00 - Valves, General.

END OF SECTION

SECTION 43 30 18 - BALL VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 - Valves, General apply to this Section.

C. The requirements of Section 43 30 12 - Valve and Gate Actuators apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Sections 01 33 00 – Contractor Submittals and 43 30 00 - Valves, General.

PART 2 -- PRODUCTS

2.1 METAL BALL VALVES (4-INCHES AND SMALLER)

A. **General:** Unless otherwise indicated, general purpose metal ball valves in sizes up to 4-inches shall have actuators in accordance with Section 43 30 12 - Valve and Gate Actuators.

B. **Body:** Valves 1-inches to 4-inches in size shall have bronze or carbon steel 2 or 3 piece bodies with flanged ends for a pressure rating of ANSI 125 psi or 150 psi unless otherwise indicated.

C. **Balls:** The balls shall be solid chrome-plated brass or bronze, or stainless steel, with standard port (single reduction) or full port openings.

D. **Stems:** The valve stems shall be of the blow-out proof design, of bronze, stainless steel, or other acceptable construction, with reinforced teflon seal.

E. **Seats:** The valve seats shall be of teflon or Buna-N, for bi-directional service and easy replacement.

F. Manufacturers, or Equal

1. **Conbraco Industries, Inc. (Apollo)**
2. **ITT Engineered Valves**
3. **Neles-Jamesbury, Inc.**
4. **Watts Regulator**
5. **Worcester Controls**

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with Section 43 30 00. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 43 30 20 – GATE VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide gate valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 – Valves, General apply to this Section.

C. The requirements of Section 43 30 12 – Valves and Gate Actuators apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

09 96 00	Protective Coating
43 30 00	Valves, General
43 30 12	Valves and Gate Actuators

B. Reference Standards

American Water Works Association (AWWA)

AWWA C500	Metal-Seated Gate Valves for Water Supply Service
AWWA C509	Resilient-Seated Gate Valves for Water and Sewerage Systems
AWWA C515	Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service

ASTM International (ASTM)

ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A395	Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A536	Ductile Iron Castings
ASTM B62	Composition Bronze or Ounce Metal Castings
ASTM B371	Copper-Zinc-Silicon Alloy Rod

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General apply to this Sections.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Buried valves shall be of the inside screw, non-rising stem type. The valve actuators shall be as indicated, with counter-clockwise opening stems, in accordance with Section 43 30 12 – Valves and Gate Actuators.

2.2 KNIFE-GATE VALVES (2- TO 96-INCH)

A. Construction: Knife-gate valves shall be of the flanged or wafer design, with raised face and resilient seats for positive seating. Wetted parts shall be constructed of Type 316 stainless steel, and the gates shall be finish-ground on both sides to prevent packing or seat damage. Valves 2- to 12-inches in size shall be furnished with cast stainless steel bodies; valves 14-inches and larger shall have semi-steel bodies with stainless steel linings. The valve stem shall be of stainless steel with a long-life packing. The valves shall be rated for tight shut-off at the following pressures:

1. Valve sizes 4- to 12-inches 150 psi (bi-directional)

2. Valve sizes larger than 12-inches 50 psi

B. Actuators: Knife-gates shall have outside-screw and yoke-rising stems with manual handwheel actuators, unless otherwise indicated, in accordance with Section 43 30 12 – Valves and Gate Actuators.

C. Manufacturers, or Equal

1. DeZURIK Water Controls Corporation

2. Fabri-Valves

2.3 PLASTIC GATE VALVES (1-1/2 TO 14-INCHES)

A. Construction: Plastic gate valves shall have PVC bodies with ANSI 150 lb. flanged ends, and polypropylene or CPVC-SBR-lined wedges for tight shut-off. The non-rising stem shall be of PVC or Type 304 stainless steel construction, with O-ring seal. The valves shall have a coldwater pressure rating of 150 psig for sizes 1-1/2 through 8-inches, 110 psig for size 10-inches, and 70 psig for sizes 12- and 14-inches.

B. Actuators: Unless otherwise indicated, PVC gate valves shall have manual handwheel actuators with position indicators, in accordance with Section 43 30 12 – Valves and Gate Actuators.

C. Manufacturers, or Equal

1. ASAHI/America

2. Spears Mfg. Co.

PART 3 -- EXECUTION

3.1 GENERAL

A. Gate valves shall be installed in accordance with the provisions of Section 43 30 00 – Valves, General apply to this Section. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 43 30 52 - MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 - Valves, General, apply to this Section.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 - Valves, General.

PART 2 -- PRODUCTS

2.1 AIR-VACUUM AND AIR-RELEASE VALVES

A. Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength cast iron. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.

B. Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.

C. Manufacturers, or Equal

1. **APCO (Valve and Primer Corporation)**
2. **Crispin - Multiplex Manufacturing Company**
3. **GA Industries**
4. **Val-Matic (Valve and Manufacturing Corporation)**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's printed recommendations.

B. Air and vacuum release valves shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

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SECTION 43 30 62 - SLIDE GATES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide slide gates, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer

1. The CONTRACTOR shall assign to a single manufacturer responsibility for the furnishing and functional operation of the hydraulic gates, including operators and accessories.

2. The designated single manufacturer, however, need not manufacture more than one part of the units, but shall coordinate the design, assembly, testing, and installation of the units.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C561	Stainless Steel Slide Gates
ASTM B 21	Naval Brass Rod, Bar, and Shapes
ASTM B 584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. Submit the following:

a. Drawings of gates, frames, slides, and actuators

b. Design load calculations for deflection at the maximum expected head

c. Calculations for the lifting force generated by 40 pounds effort on the handwheel or crank in order to operate the gate.

B. Technical Manuals

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.

C. Field Procedures

1. Prior to installation of the gates, provide instructions for field procedures for installation, adjustments, inspection, and testing.

1.4 QUALITY ASSURANCE

A. The leakage allowance for slide gates under the design seating and unseating heads shall conform with the AWWA Standards.

B. Factory Testing

1. Gates shall be factory-assembled and functionality-tested prior to delivery to the Site.

C. Equipment Field Testing

1. The CONTRACTOR shall be responsible for the coordination of tests of each hydraulic gate in the presence of the manufacturer's factory service representative.

2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

1.5 WARRANTY

A. The CONTRACTOR shall furnish the manufacturer's written guarantee that the hydraulic gates comply with the indicated requirements.

B. The CONTRACTOR shall furnish the manufacturer's warranties as published in its literature.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Gates shall comply with the following Standards:

1. AWWA C513 (unless indicated otherwise) Open-Channel, Fabricated-Metal Slide Gates and Open-Channel, Fabricated-Metal Weir Gates

2. AWWA C562 Aluminum Slide Gates

B. Gates shall be new and of current manufacture, adequately braced in order to prevent warpage and bending under the intended use. Indicated and necessary mountings and appurtenances shall be included.

C. Gate actuators shall be sized, selected, and furnished by the gate manufacturer.

D. Gate actuators throughout the project shall be products of a single manufacturer.

E. Mounting Requirements

1. Guide frames shall be extended 3 feet, 6 inches above the walkway in order to match the height of the handrail.

2. Where a gate is mounted in an opening between 2 sections of handrail, additional horizontal members shall be added to the gate frame to match the handrail, guardrail, and kickplate spacing of the adjacent railing.

3. Horizontal members shall be arranged such that the railing will not interfere with operation of the actuator.

2.2 ALUMINUM SLIDE GATES

A. Construction

1. Unless otherwise indicated, materials of construction shall be in accordance with AWWA C513 and C562 suitable for the service.

2. Materials used in the fabrication of the slide gates shall conform to the requirements of the standards designated for each material as indicated below:

Description	Material Standards
Aluminum Gates	
Slide	Aluminum, ASTM B 209 Alloy 6061-T6
Frame	Aluminum ASTM B 308 Alloy 6061-T6
Stem and coupling	ASTM A 276, Type 316
Hardware	ASTM A 276, Type 316
Stem Cover	Aluminum pipe with slots and indicator
Guides and seats	UHMW Polyethylene, ASTM D 4020
Seals	“J” bulb Type, Neoprene, ASTM D 2000

B. Lifting Devices

1. Provide lifting devices complete with stem, lifting nut, intermediate supports with steady bushings, stem cover, indicator, and gear reducer, hand wheel, crank, electric or hydraulic cylinder, where indicated.

2. The lifting devices shall be weatherproof.

3. The centerline of the manual actuator shall be approximately 3 feet above the base for pedestal-mounted actuators, and approximately 4 feet above the floor for frame-mounted actuators.

4. Power lifting devices shall be in accordance with Section 43 30 12 – Valve and Gate Actuators.

5. Slide gate hoist heads shall be constructed of cast iron.

6. The operating nut shall be constructed of solid bronze, in accordance with ASTM B 584.

7. Operating thrust shall be taken on roller or ball bearings.

8. Parts shall be provided with an alternative lubrication system.

9. Handwheel Crank

a. The unit shall be designed for a 40–pound maximum effort on the crank in order to operate the gate.

b. Clockwise movement of the handwheel shall close the gate.

c. The operating crank shall be easily removable in order to facilitate the use of a portable power operator.

C. Manufacturers, or Equal

1. **Golden Harvest Gates**

2. **Rodney Hunt Company**

3. **Whipps Gates**

2.3 HARDWARE

A. Bolts and nuts shall comply with the requirements of Section 05 50 00 – Miscellaneous Metalwork.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Slide gates shall be installed in strict accordance with the manufacturer's printed recommendations and the indicated requirements.

B. Operators shall be located as to avoid interference with handrails and structural members.

C. Damage to surface coatings incurred during shipment or installation shall be repaired.

END OF SECTION

SECTION 43 30 67.39 – PRESSURE REGULATING VALVE

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure sustaining valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 30 00 – Valves, General apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

40 05 51	Common Requirements for Process Valves

B. Reference Standards

ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.42	Ductile Iron Pipe Flanges and Flanged Fittings
ASTM A 48	Gray Iron Castings
ASTM A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 536	Ductile Iron Castings
ASTM B 62	Composition Bronze or Ounce Metal Castings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 43 30 00 – Valves, General.

1.4 SPECIAL WARRANTY REQUIREMENT

A. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

PART 2 -- PRODUCTS

2.1 FLANGED PRESSURE RELIEF VALVES, SIZES 1-1/2 INCHES THROUGH 42-INCHES

Valve Characteristics: The Pressure Relief/Sustaining Control Valve shall maintain a constant upstream pressure by bypassing or relieving excess pressure and shall maintain close pressure limits without causing surges. Valve will remain closed until the upstream pressure exceeds a pre-determined set point. Valve will be fast opening and modulate to limit the upstream pressure to a pre-determined set point. If upstream pressure decreases below the pilot spring setting, the valve shall close. Valve will be slow closing to prevent surges.

A. Valve Body: The valve body shall be of ductile iron to ASTM A 536 - Ductile Iron Castings, with flanged ends to ASME B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings. The valve cover shall be flanged and be of the same material as the body.

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B. Valve Trim: The valve stems, springs, body seat rings, and bolts, nuts, and washers shall be of Type 302, 303, or 316 stainless steel. The valve stems shall have top and bottom guides. Rubber parts shall be Buna-N. The diaphragms shall be of Nylon-reinforced Buna-N, supported firmly between body and valve cover. The valve pistons and piston liners shall be bronze to ASTM B 62 - Composition Bronze or Ounce Metal Castings.

C. Valve Controls: The valve shall be furnished with a complete, externally-mounted control system, including adjustable speed control needle valves, strainer, and necessary copper or stainless-steel connecting tubing and fittings. The controls shall be capable of achieving the flow and speed adjustment indicated.

D. Factory Tests: Valves shall be factory tested with a hydrostatic test and a functional test and a test certificate shall be submitted to the Engineer prior to delivery of the valve.

E. Operating Conditions: The valve shall be designed to operate under the following conditions:

Total flow from pump station, gpm	800
Maximum inlet pressure, psi	27
Maximum flow through valve, gpm	800
Valve size, in	6
Diameter of pipeline, in	8

F. Spare Parts: The following spare parts shall include:

1. One complete set of resilient seals and discs

G. Manufacturers, or equal

1. Cla-Val Company
2. Golden-Anderson
3. OCV Control Valves

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 43 30 00 – Valves, General.

3.2 SERVICES OF MANUFACTURER

A. Inspection, Startup, and Field Adjustment: The service representative of the valve manufacturer shall be present at the Site for 1 Day, to assist the Contractor in the installation and adjustment of the valve(s).

B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the Site for 4 hours to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a Day is defined as an 8-hour period, excluding travel time.

END OF SECTION

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SECTION 43 40 10 – FIBERGLASS REINFORCED PLASTIC TANKS

PART 1 --GENERAL

1.1 THE SUMMARY

A. **General:** The CONTRACTOR shall furnish all labor, equipment, materials, tools, supplies, fittings, and appurtenances required for the fabrication, support, installation, anchorage, hook-up, lining, protective coating, testing and backfilling of fiberglass-reinforced plastic tank(s), and all appurtenant work, for a complete and workable installation as specified herein, in accordance with the requirements of the Contract Documents.

B. The items specified under this Section shall be furnished by Manufacturers having experience in the manufacture of similar products and having a record of successful installations.

C. All plastic and fiberglass items shall be manufactured of material suitable for potable water and shall be certified for such use on the shop drawings. Tanks shall be designed and checked for all loads to be incurred during service.

1.2 CONTRACTOR SUBMITTALS

A. **Shop Drawings:** The CONTRACTOR shall furnish shop drawings of all items and accessories in accordance with the requirements of Section 01 33 00 - Contractor Submittals. Shop drawings shall include bill of materials listing all components, resins, catalysts, promotors, ultraviolet light absorbers, agents, reinforcing materials, etc., with Manufacturer's name, trade and identification marks. The laminate sequence used for all tanks must either be attached to or included on drawings used by the fabricator's shop personnel.

B. **Data Requirements:** The shop drawings and data submitted shall include the following:

1. Dimensions.
2. Details of structural support members.
3. Equipment capacity (gallons).
4. Maximum design specific gravity.
5. Equipment weight, empty and filled with water.
6. Laminate sequence of construction and all materials of construction listed.
7. Specifications for all supplied bolting, gaskets and accessory items.

PART 2 --PRODUCTS

2.1 TANK DESIGN

A. **Standards:** Construction of tanks shall be in accordance with ASTM standards listed herein and other accepted industry standards for raceway tank design.

B. **Design:** Fiberglass tanks shall be constructed using the contact molded method. Tank sidewall thickness shall have a continuous taper not made of stepped thickness courses.

C. **Dual Drain Circular Rearing Tanks:** A total of 8 tanks shall be provided complete with stainless steel side and bottom outlet screens, PVC standpipes with Fernco-style couplings, weir plates and pipe supports. The tanks shall have nominal inside dimensions of 26-feet in diameter by 5'-0" deep at the perimeter and shall have a conical base sloping towards the center sump. The tanks may be fabricated in multiple pieces and field joined with fiberglass to create a single integral tank structure. The sides may taper inward slightly to facilitate removal from the mold. The tanks shall be provided in two configurations, 4 shall be as shown on the drawings and 4 shall be mirrored so that the fish release outlet pipe is on the left side of the drain box and the position of the effluent discharge pipe and the side outlet screen are reversed within the drain box.

D. **Tank Mesh Covers:** Covers shall be provided for each outdoor circular rearing tank complete with a cover frame and mesh panel, as indicated in the drawings:

1. Mesh panels shall consist of 210D/36 knotless nylon netting, cut and mounted to form approximately 1" square openings. Panels shall include a 3/8" braided polyester machine sewn rope border around the base perimeter and for an opening flap. Connections to the mesh cover to the frame shall be designed by the CONTRACTOR.

2. Mesh panels shall be provided by Christensen Net Works.

2.2 MATERIALS OF CONSTRUCTION

A. **Resin:** Resin shall be manufacturer's standard polyester resin or approved equal. To ensure that fresh resin is used, at the completion of the job, lot numbers of the resin used must be shipped with the completed tank. Fillers up to 2 percent by weight of thixotropic agent may be used for viscosity control in the paraffinated topcoat on vertical surfaces, provided it will not interfere with visual inspection. The cure system used for the resin shall be in accordance with resin Manufacturer's current recommendations. Proper curing of the resin is the fabricator's responsibility. All products fabricated in this specification shall be cured to at least 90 percent of the minimum Barcol hardness specified by the resin Manufacturer. The requirement applies to both interior and exterior surfaces. No chemical-resistant surface, interior or exterior, shall be acetone sensitive. Where application of polyester film to prevent air inhibition of these surfaces is impractical, a wax containing resin coating, formulated according to the resin Manufacturer's most recent recommendations, must be used. The minimum thickness of the polyester film shall be 4 mils. The outside surface of the tanks shall have a gel coat with color selection by the Contracting Officer.

B. **Reinforcement:** Chopped strand mat shall be Type E (electrical borosilicate) glass, 1-1/2 oz per sq ft, with silane finish and a styrene-soluble reactive binder. Continuous roving used in chopper gun for spray-up shall be Type E glass. Woven roving shall be Type E glass, nominal 24 oz/sq yd, 4 by 5 weave, with silane-type finish. Continuous roving used for filament winding shall be Type E glass with a silane-type finish.

2.3 CONSTRUCTION

A. **General:** Tanks shall be contact molded on a highly polished monolithic male hold.

B. **Laminate Construction:** Laminate construction shall be as follows:

1. Chemical Resistant Barrier: Tanks shall consist of an inner surface and an interior layer which constitutes the chemical-resistant barrier, and an exterior or structural layer. The inner surface shall be free from cracks and crazing, with a smooth finish. The resin-rich surface shall be between 0.010 and 0.020 inches and reinforced with C-glass. The resin rich inner surface (i.e. exposed to water) shall be a smooth highly polished gel coat. The resin to glass ratio should be approximately 90 percent resin and 10 percent glass. The interior layer shall consist of either (1)-3 layers of 1-1/2 oz/sq ft E-glass chopped strand mat, or (2)-2 layers of 1-1/2 oz/sq ft E-glass chopped strand mat followed by one pass by the spray-up process. In no case shall the combined thickness of the inner surface and the interior layer be less than 0.100 inches. The glass content for the interior layer shall be 20-30 percent.

2. Contact Molded Laminates: The contact molded process includes fabrication by the hand lay-up, contact pressure molding, and spray processes or combinations thereof, according to ASTM D 4907, except as otherwise noted. In addition, inner surface and interior layer shall be constructed as specified in the preceding paragraph. The exterior layer or body of the laminate shall provide the additional strength necessary to meet the tensile and flexural requirements. Where separate layers such as mat or woven roving are used, all layers shall be lapped a minimum of one inch (two inches for woven roving). Laps shall be staggered as much as possible. If woven roving is used, a layer of chopped strand glass shall be placed as alternate layer. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections. On laminates containing woven roving, cut edges exposed to the chemical environment shall be coated with resin, surfacing mat, and C-glass veil, and all machined flange faces shall be faced with C-glass.

3. Outer Surface: When air-inhibited resins are cured with an air-exposed surface, a wax-containing resin coating, formulated according to the resin Manufacturer's most recent recommendations, must be used.

4. Tank Exposed Edges: The exposed edges on the top of the vertical sidewall of all tanks shall have a minimum of a 180 degree rounded edge with a minimum radius of 0.5 inches to prevent the Operators from getting skin scrapes or splinters when working around and over the tank side wall.

5. Screens, Weir Plates and Standpipes: The manufacturer shall provide the tanks with the screens, weir plates and standpipe assemblies shown on the drawings. The bottom screen shall be constructed such that it is held firmly in place when the tank is in use and can be easily removed for fish release at the end of the

rearing period. A twist-lock or similar screen retention mechanism is envisioned. The removal process shall be accomplished without the need to lower the water level in the tank or use tools to remove retaining screws or other fasteners.

2.4 WORKMANSHIP

A. **Tank Deflection:** The tanks shall be constructed such that there is less than a 1" deflection of the tank walls for a full tank.

B. **Visual Defects:** ASTM D2563 shall be used for quality control of both filament-wound and hand lay-up construction. Acceptance levels shall be as follows:

Interior Surface:	Defects:
Blisters	None
Burned Areas	None
Chips	None
Cracks	None
Crazing	None
Dry Spots	None
Entrapped Air	None at surface. If in laminate 1/16-in dia max and 5/sq in max.
Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None
Pits	Max 1/16-in dia X 1/32-in deep, max 10/sq ft.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 10 percent of wall thickness.
Sharp Discontinuity	None
Exterior Surface:	**Defects:**
Blisters	Max 1/4-in X dia 1/16-in high.
Burned Areas	None
Chips	Max 1/4-in with max thickness of 20 percent of wall.
Cracks	None
Crazing	Slight
Dry Spots	Max 2 sq in/sq ft
Entrapped Air	1/8-in dia max; no more than 3 percent of area.

Exposed Glass	None
Exposed Cut Edges	None
Foreign Matter	None if it affects the properties of laminate.
Pits	Max 1/8-in dia X 1/16-in deep.
Scratches	None (coated)
Surface Porosity	None
Wrinkles	Max deviation 20 percent of wall thickness, but not exceed 1/8-in.
Sharp Discontinuity	None

If the area fails to meet the requirements of entrapped air or voids in less than 40 percent of the total surface, those areas may be repaired and reinspected. If the defective areas exceed 40 percent of the total surface, the entire vessel shall be rejected.

2.5 BOLTS, ANCHOR BOLTS, WASHERS, SUPPORTS, AND HOLD DOWN LUGS

A. The CONTRACTOR shall provide all bolts, anchor bolts, nuts, washers, and supports as required for all the plastic and fiber glass items specified in this Section, and in accordance with the requirements of the Manufacturers of the plastic and fiber glass items. All bolts, anchor bolts, washers, hold down lugs, and supports required in connection with the plastic or fiber glass items provided under the Section shall be of Type 304 or 316 stainless steel.

2.6 ACCEPTABLE MANUFACTURERS

A. **Reiff Manufacturing Inc., Walla Walla, WA; (509) 525-1081;**

B. **D&T Fiberglass, Inc., Sacramento, CA; (916) 383-9012**

C. **Red Ewald, Inc., Karnes City, TX; (512) 780-4272**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. All fiber glass reinforced plastic tanks shall be leveled and positioned in the desired location and elevation on concrete blocks or other non-degrading supports and then backfilled with a sand slurry or flowable fill in accordance with the manufacturer's recommendations. All pipe connections to the tanks shall be firmly supported, to avoid stresses on the tank.

3.2 FIELD INSPECTION

A. The field inspection shall include the following:

1. An acetone wipe test of field laminated areas to check for surface cure. No surface tackiness is permitted.

2. A hydro-static test of at least 24 hours duration to check for leaks and deflection of the tanks.

3. Visual inspection of screen and baffle fit and “fish-tight” installation.

END OF SECTION

SECTION 43 52 04 – PORTABLE DAVIT CRANE AND HOIST

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide one (1) manual davit crane, complete and operable, in accordance with the Contract Documents. The davit crane is intended to be dual purpose, the first for lifting the existing fish ladder entrance bar screen screen near the base of the fish ladder and the second for removing the tailrace diffuser screen.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Technical manuals in accordance with Section 01 77 00 – Closeout Procedures.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Requirements

1. The davit crane shall be a portable hand operated unit for mounting in a pedestal base. Provide two pedestal bases. The first pedestal base will be mounted on top of the intake structure in between pumps P-301 and P-302. These second pedestal base will be mounted in between pump P-303 and the space reserved for an additional pump.

B. Site Conditions

Equipment No	DC-301
Location	Pumped Intake
Atmosphere	Outdoors

C. Construction: The davit cranes shall be designed as follows:

1. Galvanized steel construction with spur gear winch with a stainless steel wire rope.

2. Winch shall be a hand operated type with a brake for load control.

3. Davit crane shall have a telescoping boom that can also be adjusted to achieve an operating radius range of 72 inches to 120 inches. Height adjustment shall be by means of a screw jack. Boom shall telescope to 4 pre-set lengths.

4. Bases shall be constructed from stainless steel and shall be a pedestal mount style as appropriate to their location as shown on the drawings

D. Capacity and Dimensions:

Capacity, lbs	2,800 lbs at a 72-inch hook radius (Mast Position “A-1”)
Max Lift, Max Lift feet	9
Wire Rope size, length	3/8 inch Stainless Steel, 45 ft

E. **Manufacturers, or Equal:**

1. Thern Captain 2500 5FT25

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

1. Davit cranes and bases shall be installed in strict accordance with the manufacturer's published or written instructions.

3.2 FIELD TESTING

A. After completion of the WORK, the CONTRACTOR shall test crane equipment in the presence of the manufacturer's field representative, who shall certify in writing that the equipment meets applicable standards and specifications.

END OF SECTION

SECTION 46 01 00 - EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide equipment and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to equipment throughout the Contract except where otherwise indicated.

C. Equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available from manufacturers at the time of design and is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic and some features of the illustrated equipment arrangement may require revision by the CONTRACTOR to meet the actual equipment requirements proposed by the CONTRACTOR. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered by the CONTRACTOR to accommodate the equipment provided. No additional payment will be made to the CONTRACTOR for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the fabrication of equipment.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Equipment shall be in accordance with the following standards, as applicable and as indicated in each equipment specification:

1. American Society for Testing and Materials (ASTM).
2. American National Standards Institute (ANSI).
3. American Society of Mechanical Engineers (ASME).
4. American Water Works Association (AWWA).
5. American Welding Society (AWS).
6. National Electrical Manufacturers Association (NEMA).
7. Manufacturer's published recommendations and specifications.
8. Occupational Safety and Health Administration (OSHA).
9. Hydraulic Institute (HI)

B. The following standards are referenced in this Section:

ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800

ASME B16.5 Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys

ASME B46.1	Surface Texture
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
ASME B31.3	Process Piping
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. **Shop Drawings**: Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the ENGINEER, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the CONTRACTOR.

C. **Spare Parts List**: The CONTRACTOR shall obtain from the manufacturer and submit as part of Shop Drawings a list of included and suggested spare parts for each piece of equipment. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

1.4 QUALITY ASSURANCE

A. Costs: Responsibility shall be the CONTRACTOR'S for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The OWNER will pay for costs of power and water. If available, the OWNER'S operating personnel will provide assistance in the field testing.

B. Inspection: The CONTRACTOR shall inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, cranes, and related items to obtain required permits and certificates, and shall pay inspection fees.

C. Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

1. Machine WORK shall be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without

machined or milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

2. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The ENGINEER shall be notified of larger defects. No repair welding of such defects shall be carried out without the ENGINEER'S written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then the casting may be rejected. Costs of casting new material shall be the CONTRACTOR'S responsibility as part of the WORK.

3. Materials shall meet the physical and mechanical properties in accordance with the reference standards.

D. Machine Finish: The type of finish shall be the most suitable for the application as recommended by the equipment manufacturer in micro-inches in accordance with ANSI B46.1. In the absence of manufacturer's recommendations, the following surface finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

E. Manufacturer's Experience: Equipment manufacturer shall have a record of proven experience of at least 5 years of successful, troublefree operation in similar applications and size equal or larger than the equipment in this Contract. Where indicated in each individual equipment specifications, the CONTRACTOR shall submit this experience record to the ENGINEER for approval.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Noise Level: When the equipment is in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 105 dBA for one hour exposure per day.

B. For service factors of electric motors, see Section 26 05 10 - Electric Motors.

C. Where load classifications are not indicated, the equipment manufacturer's recommendations for service factors shall be utilized.

D. Welding: Unless otherwise indicated, welding shall conform to the following:

1. Latest revision of AWWA D100.

2. Latest revision of AWWA C206.

3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent corrosion of hard-to-coat metallic surfaces.

4. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

5. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

E. Protective Coating: Equipment shall be painted or coated in accordance with Section 09 96 00 - Protective Coating, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

F. Protection of Equipment: Machined and coated surfaces shall be protected by rust inhibitor material prior to shipment. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Equipment with anti-friction bearings or sleeve bearings shall be protected from being damaged due to jarring motion during shipment. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized and shafts shall be rotated per manufacturer’s recommendation. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, recoated, or otherwise corrected to restore it to original condition.

G. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

a. Pumps, compressors, and blowers of 150 horsepower or less shall receive acrylic plastic nametags.

b. Pumps, compressors, and blowers larger than 150 horsepower shall receive stainless steel plate nametags.

H. Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

I. Equipment Maximum Allowable Vibration Level: Unless otherwise indicated, maximum allowable vibration level shall be in accordance with the acceptance criteria recommended by the reference Standard for that particular type of equipment

J. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

K. Controls: Equipment and system controls shall be in accordance with Division 40 - Instrumentation.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Equipment components and supports, anchors, and seismic restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. See design criteria indicated on General Structural sheets.

1. Anchors: Anchor bolts shall be in accordance with Section 05 05 19 Post-Installed Anchors in Concrete and Section 05 50 00 - Miscellaneous Metalwork. CONTRACTOR shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the Shop Drawings.

2. Equipment Foundations: Unless otherwise indicated, mechanical equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on minimum 3.5-inch high concrete bases. Unless otherwise indicated on the Drawings, pumps, blowers, compressors and engine driven equipment shall be provided with a concrete foundation with a total weight equal to at least five times the weight of the equipment. Concrete foundations shall be isolated from the building floor in order to prevent transfer of vibration from the equipment to the building structure. The CONTRACTOR through the equipment manufacturer shall verify the size and weight of equipment foundation to insure compatibility with equipment.

3. Equipment Grout: Mechanical equipment installed on top of concrete foundations or bases shall be provided with non-shrink concrete or epoxy grout as indicated and as specified in Section 03 60 00 - Grouting. Grout shall be applied between the base plate and the concrete foundation or base in accordance with the grout manufacturer’s recommendation. Grout shall be free of void space.

2.3 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the ENGINEER.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron, ductile iron, or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be selected by the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.

F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the CONTRACTOR shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.4 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains meeting ASME Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.5 SPROCKETS

A. General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with keyseat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with Taper-Lock bushings as required.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.6 BEARINGS

A. General: Bearings shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).

B. To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life, years**	**L-10 Design Life, hours**
	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer. In accordance with the Lead Reduction Act, sleeve bearings containing lead material exposed to drinking water shall not be acceptable.

H. Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide heat exchangers, incluging necessary intrumentation and controls, piping, filters, and valves.

2.7 PIPING CONNECTIONS

A. Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 40 05 07 - Pipe Supports.

B. Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 40 05 00 - Piping, General.

C. Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the specifications.

2.8 GASKETS AND PACKINGS

A. Gaskets and packings shall be in accordance with the requirements of the specifications. Gaskets and packings in contact with drinking water shall be NSF 61 approved. Elastomeric materials in contact with water with chloramines, or water with ozone residual shall be made of Teflon or Viton-A, or equal.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane Everseal, or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the ENGINEER, in accordance with Section 43 20 00 - Pumps, General.

2.9 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.10 TOOLS AND SPARE PARTS

A. Tools: The CONTRACTOR shall furnish one complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. Spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.11 EQUIPMENT LUBRICANTS

A. The CONTRACTOR shall provide lubricants for equipment during shipping, storage, and prior to testing, in accordance with the manufacturer's recommendations. Lubricants that could come in contact with potable water shall be food grade lubricants. After successful initial testing, final testing, and satisfactory completion startup testing per Section 01 75 00 - Equipment Testing and Plant Startup, the CONTRACTOR shall conduct one complete lubricant change on equipment. In addition, the CONTRACTOR shall be responsible for the proper disposal of used lubricants. The OWNER will then be responsible for subsequent lubricant changes

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Installation, Supervision, Inspection, Startup, and Field Adjustment: An authorized, experienced, and competent service representative of the manufacturer shall visit the Site to perform the following:

1. Supervision of the installation of the equipment

2. Inspection, checking, and adjusting the equipment and approving its installation

3. Startup and field testing for proper operation, efficiency, and capacity

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements

5. Certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

6. Unless otherwise indicated, factory representative shall be present at the job site for half a day.

B. Owner Staff Training

1. Owner staff training shall be in accordance with Section 01 79 00 – Owner Staff Training.

2. Unless otherwise indicated, a minimum of one 4-hour training session shall be provided for each type of equipment.

3.2 INSTALLATION

A. General: Equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment: Equipment shall be field tested to verify proper alignment.

3.3 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the CONTRACTOR shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (as safety interlocks, etc.) other than required by the Contract Documents, the CONTRACTOR shall coordinate such features with the ENGINEER and provide material and labor necessary for a complete installation as required by the manufacturer.

3.4 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with Never Seize compound or equal.

3.5 WELDING

A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface.

3.6 FIELD TESTS

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.

2. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

C. The ENGINEER shall witness field-testing. The CONTRACTOR shall notify the ENGINEER of the test schedule 3 Days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION

SECTION 46 21 33 - DRUM FILTERS

PART 1 -- GENERAL

1.1 SUMMARY

A. The CONTRACTOR shall provide microscreen drum filters, complete and operable, in accordance with the Contract Documents. Each Drum Filter shall consist of the driveline, filter elements, drum structure, spray bar, sludge trough, support bearings, liquid level control, high-pressure rinse system, control panel, upstream overflow weir where applicable, and other components necessary for a complete and operable system.

B. The requirements of Section 46 01 00 – Equipment General Provisions, apply to the WORK of this Section.

1.2 SUPPLIER QUALIFICATIONS

A. The drum filter manufacturer / distributor shall have a minimum of 5 years experience in design manufacturing and installation of drum filters in aquaculture applications. Upon request, the drum filter manufacturer shall supply not less than 10 aquaculture references including company name and contact information.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer's literature and drawings demonstrating compliance with this Section.

2. Dimensional drawings showing, at minimum, the following:

a. Equipment dimensions including minimum recommended clearances;

b. Materials of construction;

c. Arrangement of equipment internals;

d. Maximum and minimum operating water levels;

e. Leveling and anchoring requirements

f. Control panel size and layout

g. Wiring schematic

C. Product information or catalog cuts for buyout components.

D. Technical Manuals

E. Certificate or letter of confirmation of equipment warranty

1.4 WARRANTY

A. The Manufacturer shall warrant all equipment for a period of 12 months from startup.

B. During the warranty period, the Manufacturer shall replace or repair non-consumable parts proved to be defective in material or workmanship upon written notice, provided that the equipment is installed in accordance with the manufacturer's instructions and operated and maintained in accordance with the instructions contained in the manufacturer's Technical Manual.

C. The Manufacturer shall be liable for the direct labor and material costs of repairs or replacement performed by the Owner during the warranty period, but only if the Manufacturer gives prior authorization in writing for the repair or replacement involved.

PART 2 -- PRODUCTS

2.1 DESIGN AND CONSTRUCTION

A. **Driveline:** The drum filters shall have helical worm gearbox coupled to the drum filter drive shaft .

B. **Filter Element:** The filter cloth shall be bonded to polyethylene grids measuring 0.8" x 0.8" x 0.4". Each filter element shall be secured to the drum frame. An individual filter element shall be easily removed without removal or disengagement of additional filter elements. The filter element shall be sealed to the drum structure utilizing EDPM type gasket material to provide watertight closure.

C. **Drum Structure:** The drum structure shall be watertight structure.

D. **Drum Support:** The drum shall be supported on a central axle or multi-point bearing system utilizing idler wheels on the inlet end.

E. **Spray Bar:** The drum filter shall have one common spray bar providing five nozzles per filter element width with overlapping coverage. ¼ turn quick release nozzle tips shall be used for easy cleaning and maintenance. The quick release nozzle cap shall be made of nylon with an EDPM gasket and stainless steel spray tip.

F. **Sludge Trough:** The trough shall be capable of capturing solids from top dead center to 75 degree in clockwise direction from the inlet end view. Lateral arms attached to the drum frame shall support the sludge trough, permitting the drum to rotate unobstructed.

G. **High Pressure Rinse System:** The system shall consist of a booster pump, 316SS ball valve, brass solenoid valve, PE line strainer, high-pressure hose and 316SS fittings between the pump and filter.

H. **Integral Pan for Maintaining Minimum Water Level:** Each drum filter shall be provided with an integral pan that maintains the required minimum submergence at the screen without requiring a separate downstream weir.

I. **Overflow Weir:** The filters shall be provided with overflow weir(s) to prevent the differential water level across the drum from exceeding 15". For basin mounted units, the overflow weir shall be fabricated from stainless steel and mounted external to the unit. For tank-style units, integral internal weirs shall be provided.

J. **Liquid Level Control**

1. All electrical components shall be enclosed in a Allied Molded NEMA 4X enclosure and include a HAND-OFF-AUTO selector switch, drive VFD, booster pump

starter/overload relay, 50 VA control voltage transformer, off delay relay, terminal blocks and mechanical float switch with 30' lead. The controls shall include contacts for remote status and alarm reporting to indicate that each filter is cleaning and if each filter is in an alarm condition.

2. The HAND position immediately engages the respective drive (VFD or starter/overload relay), booster pump starter/overload relay and solenoid valve. The rinse cycle runs continuously until the selector switch is returned to the off or auto position.

3. The AUTO position engages an off delay relay to sense water level with the mechanical float switch. When the water level reaches the float switch and closes its contacts the relay engages the drive (VFD or starter/overload relay), booster pump starter/overload relay and solenoid valve to begin the rinse cycle. As the drum rotates, clean filter elements enter the water stream thus lowering the water level and opening the float switch contacts. The off delay relay continues the rinse water cycle for a selected period of time before disengaging the drive (VFD or starter/overload relay), booster pump starter/overload relay and solenoid valve to end the rinse cycle. Thus, ensuring complete cleaning of the filter elements. The system is reset to begin the next cycle.

2.2 TOOLS AND SPARE PARTS

A. As applicable, special tools shall be furnished in accordance with Section 46 01 00 - Equipment General Provisions.

1. **Spare Parts:**

a. One complete set of filter elements

b. 10 nozzle tips with nuts and gaskets

c. 2 roller wheels for each nominal drum size.

d. 1 rubber lip seal for each nominal drum size.

e. 1 booster pump for the high pressure rinse system

f. 1 drive motor

B. SYSTEM REQUIREMENTS

C. Drum filters shall meet the following system design requirements:

Equipment Number(s)	DF-401, DF-402, DF-403
Location	Water Supply Headbox
Standard Tank Supplied by Manufacturer (Yes/No)	No
Minimum Capacity, gpm/each	2,400
Minimum Nominal Drum Size, mm	1600

Minimum Downstream Operating Depth, mm	609
Filter Opening, µm	40
Maximum Suspended Solids, mg/L	25
Electrical Requirements	460 V; 3 Phase; 60 Hz
Sludge Outlet Pipe Diameter, inch	4-5
Rinse Water Flow at 100 psi, gpm	10 - 35
Rinse Water Pump Size, kW	1.5 - 4

2.3 MANUFACTURERS OR APPROVED EQUAL

A. **Hydrotech Drum Filters** (Contact: Ian Race, Ian.Race@praqua.com, 250-824-0242)

B. **Integrated Aqua Systems, Inc.** (Contact: Ryan Karcher, rk@integrated-aqua.com, 858-888-5172)

C. **Innovasea Land Systems NP Drumfilter** (Contact: Constance Beaulaton, constance.beaulaton@innovasea.com, 407-619-8377)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be per the manufacturer's printed recommendations and as indicated.

3.2 START-UP SUPERVISION

A. The services of a qualified representative of the manufacturer shall be furnished by the CONTRACTOR for minimum of 1 day to check the installation, start-up the equipment and instruct personnel in proper operation and maintenance.

3.3 OWNER STAFF TRAINING

A. Provide owner staff training for the drum filters in accordance with the requirements of Section 46 01 00 Equipment General Provisions.

END OF SECTION

SECTION 46 21 34 – PRESSURIZED SCREEN FILTERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide self-cleaning screen filters, and all appurtenant work, complete and operable, in accordance with the Contract Documents. The screen filters shall be provided mounted to a skid complete with supply and discharge piping connections, isolation and bypass valves, automated backwash valves, backwash discharge manifold, and a common control panel. All WORK shall be performed in accordance with the applicable codes and regulations.

B. The Screen Filters shall be low-pressure type.

C. The requirements of Section 46 01 00 – Equipment General Provisions, apply to the WORK of this Section.

1.2 SUPPLIER QUALIFICATIONS

A. The screen filter manufacturer / distributor shall have a minimum of 5 years' experience in design manufacturing and installation of screen filters. Upon request, the screen filter manufacturer shall supply no less than 10 aquaculture references including company name and contact information.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

B. Shop Drawings

1. Manufacturer's literature and drawings demonstrating compliance with this Section.

2. Dimensional drawings showing, at minimum, the following:

a. Equipment dimensions including minimum recommended clearances;

b. Materials of construction;

c. Arrangement of equipment internals;

d. Leveling and anchoring requirements;

e. Control panel size and layout;

f. Wiring schematic.

C. Product information or catalog cuts for buyout components.

D. Technical Manual

E. Certificate or letter of confirmation of equipment warranty

1.4 WARRANTY

A. The MANUFACTURER shall warrant all equipment for a period of 12 months from date of successful pre-commissioning.

B. During the warranty period, the MANUFACTURER shall replace or repair non-consumable parts proved to be defective in material or workmanship upon written notice, provided that the equipment is installed in accordance with the manufacturer's instructions and operated and maintained in accordance with the instructions contained in the MANUFACTURER's Technical Manual.

C. The MANUFACTURER shall be liable for the direct labor and material costs of repairs or replacement performed by the OWNER during the warranty period, but only if the MANUFACTURER gives prior authorization in writing for the repair or replacement involved.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The screen filters shall be provided pre-installed in a vertical stack configuration on a common skid. The skid shall include flanged connections for supply and discharge piping, isolation valves for each filter unit, a bypass valve, supports for the screen filters, flush valves and actuators, a common manifold for backwash discharge with flanged connections, integrated control panel, and control instrumentation.

B. Equipment Requirements

Equipment No	SF-510
Location	Incubation Building Mechanical Room
Atmosphere	Indoors
Flow Rate	800 GPM
System Operating Pressure, Supply Side (psi)	20
Fine Filter Opening Size	10 micron
Maximum Skid Footprint Dimensions	115" x 50"
Supply, Discharge, and Bypass Pipe Size	8 inches
Backwash Discharge Pipe Size	2 inches

Electrical Supply	120/240 VAC, 1-Phase, 60 Hz

2.2 DESIGN AND CONSTRUCTION

A. Coarse Screen Pre-Filter

1. The coarse screen pre-filter shall be constructed of stainless steel 316L with perforations to protect the fine screen from damage.

B. Fine Filter Element

1. The fine screen filter shall be constructed of stainless steel 316L or better.

2. Provide supports for the filter

C. Pressure Differential Gauge

1. The differential pressure switch shall be preset at 7-psi and enclosed in a NEMA 4X enclosure. The differential pressure switch shall have an easy to read “pointer & dial” gauge.

D. Flush Valves

1. The flush valve shall be stainless steel with an electric actuator. Flange holes shall meet Class 150 flange locations. Valve shall be rated for up to 175 PSI service. The actuator enclosure shall be NEMA 4X rated. Valve position will be indicated on a valve status display.

E. Suction Scanner

1. The suction scanner lateral movement shall be regulated with a linear actuator.

F. Electronic Backwash Controller

1. Electronic backwash controller shall monitor and activate cleaning cycles.

2. Controller shall be capable of operating a single filter or up to four filters in parallel.

3. Controller shall be capable of activating a backwash cycle by each of the following: periodic timer, differential pressure, and manual activation.

4. Controller shall include a display monitor to indicate controller status and display the backwash count and timers.

G. Isolation Valves

1. Provide butterfly isolation valves with manual lever arm actuators integrated with the skid. See requirements of Section 43 30 14 Butterfly Valves.

H. Skid

1. Provide a structural skid frame designed to support all components of the supply package. Anticipated plan dimensions are approximately 64” x 36”.

2. All skid components shall be stainless steel 304 or better unless otherwise specified.

3. Skid shall include lifting eyes, or equivalent, to allow the skid to be lifted as a single unit.

4. Provide anchoring locations in each corner of the skid. Supplier shall provide guidance for anchor type and minimum anchor embedment into the concrete.

2.3 TOOLS AND SPARE PARTS

A. As applicable, special tools shall be furnished in accordance with Section 46 01 00 - Equipment General Provisions.

2.4 MANUFACTURERS OR APPROVED EQUAL

A. **Forsta Filters**

B. **Amiad**

C. **Tekleen**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be per the manufacturer's printed recommendations and as indicated.

3.2 START-UP SUPERVISION

A. The services of a qualified representative of the manufacturer shall be furnished by the CONTRACTOR for minimum of 1 day to check the installation, start-up the equipment and instruct personnel in proper operation and maintenance.

3.3 OWNER STAFF TRAINING

A. Provide owner staff training for the screen filters in accordance with the requirements of Section 46 01 00 - Equipment General Provisions.

END OF SECTION

SECTION 46 21 56 – INTAKE FISH SCREENS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide two (2) stainless steel, electrical driven, self cleaning, Cylindrical Intake Screens (CIS) and fittings in accordance with the requirements of the Contract Documents.

1.2 DESCRIPTION

A. This section covers the contract item which includes the following:

1. Furnishing, installing, and testing at the location shown.

2. The CIS shall include the following:

a. Drum shaped fish screen with a suction piping through the rotating joint as shown to the connection to the pipeline.

b. Lifting eye to allow the screen to be lifted in and out of the water.

c. Screen includes 24" flange for connection to knife gate.

d. A self-cleaning system consisting of one (1) external brush-cleaning arm and one (1) spiral internal brush bar that cleans the screen surface as the CIS drum rotates.

e. Electric drive, brush-cleaning system, and wedge wire drum screens with 304 stainless steel construction, integrated into the screen unit to power the cleaning system.

f. Testing and commissioning.

g. Spare parts.

B. The equipment furnished shall be fabricated, assembled, erected, and placed in proper operating conditions in conformity with approved detail drawings, specifications, engineering data, and recommendations of the equipment manufacturer.

1.3 SUPPLIER

A. The CIS shall be designed and furnished by a single supplier with demonstrated experience with similar intake screening systems; **Intake Screens, Inc.** or approved equal.

1.4 REFERENCES

A. The following publications form a part of this specification to the extent referenced.

1. American Society for Testing and Materials (ASTM):

a. ASTM A 36 – Standard Specification for Carbon Structural Steel.

b. ASTM A 276 – Specifications for Stainless Steel Bars and Shapes.

2. American Welding Society:

   a. AWS D1.1 – Structural Welding Code – Steel.

   b. AWS D1.6 – Structural Welding Code – Stainless Steel.

1.5 CONTRACTOR SUBMITTALS

A. Submit the following:

1. Product data, make, model of manufactured components. To include: drum screen; general arrangement of system components; physical dimensions and weights of components; and any required coatings

2. General arrangement drawingd of the CIS, including the layout and configuration.

3. Construction materials used in the project, including product data sheets and other material used in the project.

4. List of spare parts to be furnished.

5. Two (2) sets of detailed operation and maintenance manuals. The manuals shall include basic installation, removal, inspection, operating, and maintenance procedures for personnel.

6. Welder certifications using stainless steel and carbon steel as appropriate.

PART 2 -- PRODUCTS

2.1 INTAKE SCREEN CIS

A. General:

1. The CIS shall be designed to cover the intake opening and prevent the entrainment and impingement of juvenile fish while allowing water to pass freely into the intake pipeline. When the screen is installed it shall seal over the intake base.

2. The screen system shall use a brush cleaning system. The exterior of the screen shall be cleaned as the CIS drum rotates and the exterior is surface is whiped clean by the brush arm. The interior screen surface shall be kept cleaned using an internal spiral-wound brush bar that rotates as the screen turns to prevent the slots from being plugged.

3. The screen cleaning system shall be powered by an electric drive unit comprised of a 0.5 hp submersible motor coupled to a gear reducer to rotate the wedge wire cylinder between internal and external nylon brushes.

B. Fish Screens:

1. The fish screen shall be fabricated from 69V wedge wire cylinder to measure 30-inches in diameter and 48-inches long with 1.5 mm slot openings for 46% open area.

2. The fish screen shall have a support system welded to the back of the screen surface and designed for the site and intake conditions.

3. A cover plate shall be provided that will connect to the pipe/screen connection flange. The cover plate shall be placed over the entrance when the fish screen is removed from service.

4. The screen and its connection shall have no gaps larger than 1.5 mm.

5. Screen percent open area minimum: 50 percent blind.

6. The screens shall be sized to limit the approach velocity of the water to a maximum of 0.4 feet per second (fps) or less at the screen surface at the maximum flow rate of 4.06 mgd (6.28 cfs).

7. The screen shall be capable of being removed by a lifting device selected in consultation with the screen manufacturer.

C. Cleaning Brushes:

1. Brush material shall be 612 nylon.

2. Brush arms shall be stainless steel and have stainless steel clips for supporting the brush.

D. Screen Cleaning Drive Unit

1. The screen cleaning system shall consist of a electric drive unit comprised of a 0.5 hp submersible motor coupled to a gear reducer to rotate the wedge wire cylinder between internal and external nylon brushes. Submersible power and signal cable with installed wet mate connectors for connection to screen drive unit and junction box mounted on shore above the high water elevation. Cable assumed to be run inside the 20" intake pipes or in conduit provided by others. Electrical driven shaft and a hydraulic oil filled gear reducer (approximately 1000:1 ratio) that connects to the brush cleaning system.

2. Screen system includes Siemens PLC/HMI Main Control Panel (MCP) in NEMA 4 enclosure. MCP default screen cleaning frequency of three (3) cleaning cycles per day where each cleaning cycle includes 1 minute of forward cylinder rotation followed by one (1) minute of reverse cylinder rotation. Screen cleaning system to operate year-round regardless of intake operation. Operator can increase or decrease cleaning frequency and duration at the MCP.

3. MCP provides manual and automatic screen cleaning operation and screen system feedback.

4. The hydraulic oil shall be a synthetic white oil and approved by NOAA Fisheris, Chevron Clarity, or equal.

E. Rotating Suction Pipe

1. Design and furnish connecting suction pipe and swivel joint that will allow servicing of the CIS as shown on the drawings. The swivel joint shall in clude nonmetallic bushings and seals to prevent entrainment of unscreened water. No joint or fitting shall have openings larger than 3/32” diameter in any position. Suction pipeing and swivel body shall be stainless steel , type 304 .

2.2 PERFORMANCE STANDARDS

A. The CIS shall be sized so that the approach velocity of the screen is no more than 0.4 feet per second or less at a flow rate of 4.0 mgd.

2.3 MATERIALS

A. Materials shall conform to the following:

1. Fish screen unit construction, except for the motors and drive plates, shall be fabricated from ASTM A 276, Type 304 stainless steel.

2. All non-stainless steel shall conform to ASTM A 36 and epoxy coated after fabrication. Dissimilar metal connection shall be insulated with gaskets as recommended by the screen manufacturer.

3. Stainless steel bolting materials shall conform to ASTM A 193.

2.4 SPARE PARTS

A. Spare parts shall be interchangeable with, and shall be made of the same material as, the corresponding part to be replaced. Provide the following spare parts:

1. One (1) complete set of replacement brushes (both internal and external).

PART 3 -- EXECUTION

3.1 FABRICATION AND WORKMANSHIP

A. Metalwork shall be free from warp, twists, dents, buckle and other defects. Installation shall be neat, plumb, square, straight and in alignment. Provisions shall be made for expansion throughout to avoid damage. Surfaces shall be cleaned and left free from stains, marks, burrs, or other defects.

B. Welding on the fish screen units shall be in accordance with AWS D1.6 for stainless steel. Field welding and cutting operations shall be performed with tarps or shields to prevent slag or other debris from falling in the water

3.2 QUALITY ASSURANCE

A. Welders and welding operators shall be qualified in accordance with AWS D1.6 and D1.1 as appropriate. Procedure qualification tests shall be performed on samples of steel that matches the steel to be used in this section.

3.3 FIELD TESTING AND OPERATION AND MAINTENANCE MANUALS-DEMONSTRATION

A. The screen manufacturer shall perform field testing and a demonstration of the cleaning system for the ENGINEER. The testing and demonstration shall be performed in the presence of the ENGINEER.

END OF SECTION

SECTION 46 34 22 – CIRCULAR CENTER FEED CLARIFIER

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide a circular center-feed clarifier, and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The WORK under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards

1)	AGMA	American Gear Manufacturer's Association
2)	AISC	Steel Construction Manual (Latest Edition)
3)	ASTM	American Society for Testing and Materials
4)	AWS D1.1	Structural Welding Code - Steel
5)	IBC	Internation Building Code (Latest Edition)
6)	UL508A	Industrial Control Panels

B. When 2 or more of the above regulations are applicable, the more stringent requirement shall be met.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings: Include detailed bill of materials listing components, resins, catalysts, promoters, ultraviolet light absorbers, agents, reinforcing materials, etc., with manufacturer's name, trade and identification marks. The laminate sequence used for tanks must either be attached to or included on drawings used by the fabricator's shop personnel.

1) Dimensions including anchor bolt layouts.

2) Details of structural support members.

3) Equipment capacity, gallons.

4) Maximum design specific gravity.

5) Equipment weight, empty and filled with water.

6) Laminate sequence of construction and materials of construction.

7) Specifications for supplied bolting, gaskets, and accessory items.

PART 2 -- PRODUCTS

2.1 CIRCULAR CLARIFIER DESIGN

A. Standards: Construction of tanks shall be in accordance with ASTM standards listed herein.

B. Design: Circular center-feed well clarifier shall consist of a concrete circular basin complete with a center-drive type clarifier mechanism, walkway and platform, sludge rake, and v-notch perimeter overflow weir.

C. Clarifier Tank Schedule

1)	Tank ID:	CFR-701
2)	Location:	Facility Yard
3)	Description:	Circular Center Feed Clarifier
4)	Diameter (ft):	20
5)	Vertical Sidewall Height (ft):	12
6)	Nominal Freeboard (ft):	2
7)	Side Water Depth (ft):	10.00
8)	Bottom Slope (in/ft):	3/1
9)	Nominal Volume (gal):	23,500
10)	Max. Influent Flowrate (gpm):	185
11)	Center Feedwell Diameter (ft):	6 (Open top and open bottom)
12)	Center Feedwell Height (ft):	2.5 (Min.); 6.0 (Max.)
13)	Overflow Weir Type:	V-Notch
14)	Weir Notch Depth (in):	3

2.2 DRIVE UNIT

A. The drive unit shall be designed by the manufacturer.

2.3 WALKWAY AND PLATFORM

A. Walkway

1) One (1) 36 inch wide walkway and platform with handrails shall be supported by the tank wall on both ends, and shall be designed to safely withstand a live load of 50 pounds per square foot. Deflection shall not exceed L/360 when both the dead load and live loads are applied. It shall consist of two trusses or beams with 1-1/4 inch aluminum I-bar grating between the trusses or beams. The walkway shall be diagonally braced against lateral movement, and provided with handrails 42 inches

high, of double-row 1-1/2 inchdiameter horizontal aluminum pipe, and 4 inch high kickplates on both sides.

B. Center Drive Platform

1) A center drive platform shall be provided which allows 24 inches of clearance outside the center drive components. It shall consist of 0.25-inch aluminum checkered plate with necessary stiffeners and supports, resting on the drive unit, and provided with connections to the walkway. The entire platform shall be surrounded by handrails 42 inches high of double-row 1-1/2 inch dia horizontal aluminum pipe with 4-inch high kickplates.

2.4 CENTER FEEDWELL/INLET PIPE SUPPORT

A. The support for the center feedwell and the inlet pipe including the connections shall be designed by the manufacturer.

2.5 CENTER FEEDWELL

A. The center feedwell including the connections shall be designed by the manufacturer.

2.6 SLUDGE REMOVAL

A. Slude Rake

1) Sludge rake shall consist of two long slude rake arms of steel truss construction.

2) Scraper blades shall be designed for sufficient sludge transport capacity to handle the design solids loading rated, with depth of the blade varying from a minimum at the tank periphery to a maximum at the tank center.

3) Blades shall properly convey settled sludge to the sludge withdrawal point.

4) The rake speed shall be sufficient to transport the necessary volume of sludge to the sludge outlet but shall not resuspend settled sludge.

2.7 ACCESSORIES

A. V-Notch Overflow Weir

1) An adjustable weir shall be provided around the periphery of the tank at the water surface for removal of clarified effluent.

2.8 BOLTS, ANCHOR BOLTS, WASHERS, AND SUPPORTS

A. The CONTRACTOR shall provide bolts, anchor bolts, nuts, washers, and supports as required for the plastic and fiberglass items in this Section, per the contract drawings, and in accordance with the requirements of the manufacturers of the plastic and fiberglass items. Bolts, anchor bolts, washers, and supports required in connection with the plastic or fiberglass items shall be of Type 316 stainless steel, Class 2, conforming to ASTM A193 for bolts and to ASTM A194 for nuts.

2.9 ELECTRICAL

A. Manufacturer shall provide a NEMA 4X 304 stainless steel control panel to control and protect the clarifier mechanism. The control panel shall be wired to accept a 480-volt power feed, a control power transformer shall be provided to power all internal controls. The control panel shall be built in a UL508A/698 certified panel shop.

2.10 MANUFACTURERS, OR EQUAL

A. **WesTech, Inc.**

B. **Lakeside Equipment Corporation**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Fiberglass reinforced plastic tanks shall be installed as shown in the drawings.

B. Pipes and equipment connecting to the tanks shall be firmly supported to avoid stresses on the tank.

C. Piping connections shall be provided with a union.

3.2 FIELD INSPECTION

A. Field inspection shall include the following:

1) An acetone wipe test of field laminated areas to check for surface cure. No surface tackiness is permitted.

2) A Barcol hardness test of field laminated areas, at least 90 percent of manufacturer's specified hardness must be attained.

3) A hydrotest of at least 24 hours to check for leaks on field erected tanks.

END OF SECTION

SECTION 46 41 83 – PACKED COLUMN AERATORS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall furnish and install packed column aerators in conformance with these contract documents and the drawings. Each aerator shall be a complete assembly consisting of a corrugated aluminum pipe, perforated distribution and retainer plates, air intake ports, cover plate, and connection brackets. The columns shall be installed with all fasteners, anchors, appurtenances to provide a complete working system. A total of five (5) aerators are required, four (4) for the water supply headbox and one (1) at the Incubation Building.

B. The CONTRACTOR shall provide packing media for all packed columns, filling entirely the tower volume between the retainer plate and the distribution plate.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Related Work Specified Elsewhere:

1) Section 05 50 00 – Miscellaneous Metalwork

2) Section 46 01 00 – Equipment General Provisions

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 – Contractor Submittals, and shall include the following:

B. Fabrication Shop Drawings

1) Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.

2) Shop Drawings shall include complete details of members and connections, material types, weights, weld types and thicknesses, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

C. Product Information:

1) Manufacturer's literature for packing media

2) Catalog cuts for other materials or accessories included as part of the tower assemblies.

D. Anchor Submittals

1) For post installed anchors in concrete, refer to Section 01 33 17 – Structural Design, Support and Anchorage.

E. Provide instructions for field procedures for erection, adjustments, and testing.

1.4 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.

B. Fully guarantee each unit against defects in function and appearance (not caused by abuse) for a period of one year minimum from date of acceptance of project.

PART 2 -- PRODUCTS

2.1 PACKED AERATION COLUMN

A. Provide all materials, equipment, fasteners, and appurtenances necessary for the complete installation of the towers as shown on the drawings and as specified.

B. Water supply shall be a flanged connection to the cover plate attached to rim flange at the top of the column, above the distribution plate.

C. The distribution and bottom media retainer plates are mounted inside the column and shall be perforated with hole sizes as indicated. Distribution and retainer plates shall be removable from their respective assemblies. The upper portion of the column shell below the distribution top plate shall have air intake ports to allow free air flow through the media.

D. The column assembly shall be connected by stainless steel bolts with accompanying washers and nylon locking nuts and separated by a 20-durometer neoprene gasket. Fabricator shall consider access for tightening the bolts and shall tack weld nuts, if necessary, to allow bolt tightening from above only.

E. The metal fabrications for the packed towers shall be constructed entirely of aluminum type 6061-T6.

F. The column shell shall be 8 gauge aluminum CMP with 2 2/3-inch x ½-inch corrugation.

G. The media shall be P-Series 38mm polypropylene packing rings as manufactured by The Pall Ring Company, or equivalent. The design liquid loading rate shall be maximum 175 m^3/m^2-hr.

H. Packed columns shall be supported from the structural members as shown on the drawings. Packed columns must be supplied with all brackets, bolts, flanged connections, and other fasteners required for installation.

I. Air Intake Pipes: Provide Sch 40 PVC elbows and extension pipes for each air intake as shown in the drawings. PVC piping shall be solvent welded together and trimmed to final height. PVC shall be bonded to stainless steel pipe connection on the tower using suitable adhesive material.

J. Provide isolation for all dissimilar metals. See requirements of Section 09 96 00 Protective Coatings.

2.2 DESIGN CRITERIA

A. Provide the packed columns for the following conditions:

System	Qty	Flow (gpm)	Tower Diameter (ft)	Total Height (ft)	Packing Depth (ft)
Well Water	1	400	3.5	8	7
Surface Water	4	1800	5.5	9	8

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Install in accordance with all referenced requirements, and manufacturer's directions.

1) Confirm all installations are level and plumb and there is minimal to no leaking at the connections.

2) Check operation. Packed tower is to be in perfect operating service.

END OF SECTION

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SECTION 46 66 63 - OPEN CHANNEL LPHO UV DISINFECTION SYSTEM

PART 1 -- GENERAL

1.1 SUMMARY

A. General: The Open Channel Low Pressure High Output (LPHO) Ultraviolet (UV) Disinfection System shall include UV lamp modules, a programmable logic controller, in-channel intensity sensor systems, power distribution and data center, in-channel support racks, inflow perforated plate, automatic quartz sleeve wiping system, electrical, instrumentation and control components including spare parts and all other accessories in accordance with the requirements as specified herein.

B. The UV Disinfection System shall be vertical type. Like items of equipment and equipment components shall be provided by a single Supplier to ensure coordination and compatibility of equipment. The supplied UV Disinfection System shall be able to fit in the allocated space as shown in the Contract Documents and shall include a built-in access platform for servicing the unit.

C. The Supplier shall be responsible for detailing the interconnecting electrical and control wiring for all equipment system components furnished. All components of the UV Disinfection System shall be shipped to Site by the Supplier.

D. The width of the concrete channel in the reuse pump station shall be coordinated to match the approved UV unit. See notes on the design drawings.

1.2 CONTRACTOR SUBMITTALS

A. General. Submittals shall be prepared and transmitted in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings. The following information shall be furnished with the Shop Drawings:

1. Provide shop drawings and product literature including all pertinent information for the proposed equipment such as manufacturer, capacity, type, curves, certifications, accessories, physical and performance data including dose tables, finishes, and materials. Information shall include overall dimensions, range of operating water levels, and required clearances.

    a. Where proposed equipment would result in changes to the layout presented in the Contract Documents, provide general arrangements drawings (floor plans and elevations) to scales as shown on Contract Drawings showing revised layout to accommodate the proposed equipment.

2. Provide electrical schematics and layouts, including electrical single line diagrams, schematics diagrams, and interconnection diagrams. Operating characteristics of all electrical and control equipment including power consumption, operation voltage and amperage tolerances, and ancillary electrical services shall be provided.

C. Technical Manuals – Providing technical manual for equipment in accordance with the requirements Section 01 33 00 – Contractor Submittals.

1.3 QUALITY ASSURANCE

A. The UV systems shall be from a manufacturer that has had similar systems in the same vessel configuration with the same lamps pre-validated by a third party per USEPA UVDGM or NWRI protocol.

1.4 Warranty:

A. The Contractor shall provide a Manufacturer's written warranty that provides for full replacement of all defective lamps within the first 8,760 hours of operation.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide UV systems complete with UV lamp rack(s), control panel(s), and all accessories herein specified and indicated in the drawings.

2.2 PERFORMANCE AND CAPACITY REQUIREMENTS

A. The UV system design will meet the performance requirements of this Specification.

Identification No	UV-401, UV-402, and UV-403
Location	Headbox
No. of Banks	1 per channel
Flow Rate per Channel (gpm)	3,000
Maximum Allowable Headloss per Channel (inches)	2
Suspended Solids (mg/L)	< 25.0
Water UV Transmittance (%/cm)	80
Minimum UV Dose (mJ/cm2) at end of lamp life	130
Fouling Factor	0.87
End of Lamp Life Factor	0.8
Automatic Quart Sleeve Wiping System	Yes

2.3 DESIGN, CONSTRUCTION AND MATERIALS

A. General

1. General

2. All metal components in contact with water shall be Type 316L stainless steel.

3. All material exposed to UV light shall be Type 316L stainless steel, Type 214 quartz, or Teflon.

4. All wiring exposed to UV light shall be Teflon coated.

B. Lamp Array Configuration

1. The lamp array configuration shall be vertical arrays with all lamps parallel to each other and perpendicular to the direction of flow.

2. The system shall be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the water stream. Both lamp electrodes shall operate at the same temperature and be cooled by the water stream.

C. UV Lamps

1. Lamps shall be low pressure high output, mercury amalgam type lamps.

2. UV lamps shall have a monochromatic spectral output, with the emissions peaking at 254 nanometers.

3. The type of quartz used for lamp manufacture shall be compatible with wavelength emission.

4. The operating skin temperature of the UV lamp shall not exceed 130°C.

5. UV Lamps shall not require a cool down period prior to lamp re-start, should the power to the UV system fail or be interrupted for a short period of time.

6. The filament shall be significantly rugged to withstand shock and vibration.

D. Lamp End Seal and Lamp Holder

1. Each lamp shall be enclosed in its individual quartz sleeve, one end of which shall be closed and the other end sealed by a lamp end seal and compressed O-ring. The seal shall be waterproof. The O-ring compression mechanism shall require no special tools for installation or removal.

2. The quartz sleeve shall be held in-place by means of a UV resistant retaining cup. The quartz sleeve shall not come in contact with any stainless steel frame. The lamp holder shall also incorporate a UV resistant plastic cup that shall prevent the lamp sleeve from touching the steel sleeve cup

3. In the event of a quartz sleeve fracture, the seals of the lamp holder shall prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

E. UV Lamp Sleeves:

1. Clear fused quartz tubing, closed at one end shall be used. Type 219 quartz shall be used for disinfection and ozone destruction applications. Type 214 quartz also allowed.

2. Lamps shall be removable with the quartz sleeve remaining in place.

F. UV Module Support Assembly:

1. The support assembly shall be Type 316 stainless steel or other UV resistant material.

2. The top of the assembly shall serve as a UV reflector shield to prevent UV light from exiting the UV bank area when the UV lamp modules are energized and fully immersed in the effluent. Otherwise, top reflector shields shall be provided.

3. UV light shield plate shall be provided for all assemblies to prevent UV light from exiting the UV bank area when the UV lamp modules are energized and partially immersed.

4. The assembly shall allow UV lamps or sleeves to be removed without lifting the entire assembly or disturbing the rest of the system.

G. Automatic Quartz Sleeve Wiping System

1. Provide each module with an automatic quartz sleeve wiping system, operated by the PLC control system.

H. UV Intensity Monitoring:

1. Each UV module shall have a minimum of one (1) on-line, in-channel UV intensity sensor and transmitter which responds to the germicidal portion of light as measured at 253.7 nm. The sensor shall not degrade after prolonged exposure to UV light.

2. The unit shall continuously monitor the average UV intensity in the water to be disinfected and shall transmit a 4-20 mA signal to the Programmable Logic Controller (PLC), for display via the operator interface as an absolute value in mW/cm2. The accuracy shall be ± 2% of full scale transmission. The resolution shall be ± 1% of full scale transmission.

3. Initial calibration as well as calibration instructions and necessary equipment for the calibration of the UV intensity sensor shall be supplied by the Supplier. The Supplier shall field calibrate the sensor as required, using a UV transmittance monitor. The Supplier shall otherwise factory calibrate the UV intensity sensor.

I. Perforated Plate

1. Provide a perforated plate mounted vertically to the upstream of the channel units. The perforated shall promote uniform distribution of the inflow across the lamp array.

J. Temperature and Alarm Monitoring:

1. The Supplier shall supply means to protect each UV channel from over temperature, or other damaging conditions caused by loss of water flow, low water level, etc. The unit shall signal appropriate alarms to the SCADA system.

K. Electrical Components:

1. Each UV reactor shall be powered from a remote mountable System Control Center by means of a waterproof cable interfacing with a watertight strain relief.

2. The System Control Center shall be of painted steel construction.

3. Provide transformers from the UV manufacturer if system requires voltage other than the site voltage scheduled on the Drawings.

L. Control and Instrumentation

1. System control shall be microprocessor based. Operator interface is to be display type only and be located indoors.

2. The local displays main screen shall allow the operator to view current system operating statuses; providing information inclusive of: UV intensity, UV dose, system operating hours, total number of lamps operating, power level of ballasts, and any alarm conditions. Display shall allow the operator to further view alarm conditions and history, system configuration/settings, and operation.

3. Controller shall be capable of taking in a 4-20 mA input proportional to flow in gallons per minute. Controller shall calculate dose given flow and its own intensity and shall display dose and controller shall allow user to set a low dose alarm

M. Alarm Conditions:

1. The microprocessor based local display shall allow the operator to access and view the following alarm conditions:

a. Individual lamp failure – failed lamps shall be indicated by specific address (i.e. lamp #). Position in the reactor shall be indicated via lamp numbers fixed to the lamp wiring at the service end of the UV reactor.

b. Lamp life status – at the end of UV lamp(s) lifetime the elapsed time meter will flash continually for the next 240 hours to alert the operator that all lamps in the reactor require change out. A lamp life status indicator light that changes from green to orange or red for operator attention is also acceptable.

N. Alarm Signals:

1. System shall have a normally open contact so that an alarm condition can be remotely sensed.

2.4 SAFETY EQUIPMENT

A. Provide Two (2) Face Shield(s), able to block UV light wavelengths between 200 and 400nm

B. Provide Two (2) UV area warning signs (minimum 30 inches long by 3 inches tall).

2.5 SPARE PARTS

A. The following spare parts shall be furnished as part of the equipment supply package.

1. 50% of Total Number of UV Lamps provided

2. 50% of Total Number of Quartz Sleeves

3. 10% of Total Number of Electronic Ballasts with plug-in connectors

4. One (1) In-Channel UV Intensity Sensor

2.6 MANUFACTURERS OR EQUAL

A. PR Aqua

B. Innovasea

C. Glasco UV

PART 3 -- EXECUTION

3.1 GENERAL

A. The Supplier shall submit to the Contractor equipment installation instructions a minimum of 28 Days before installation begins.

B. Equipment shall have necessary lifting lugs for lifting the components into place. Components shall be lubricated at the factory as necessary to protect the equipment during shipment and storage. The UV Supplier shall be responsible for terminating all connections from the PDDC and PLC to the UV modules.

C. Contractor shall install the UV Systems per the Equipment Manufacturer's directions and the project Drawings. The Contractor will provide all required supports and anchoring required to install the UV units. The Equipment Manufacturer will provide adequate crating and protection of the UV Systems for shipment to the project site. Installation instructions will be provided that specifically outline installation of the UV system. Lifting instructions will be provided to assist the Contractor in placing the units in the mechanical room.

3.2 TESTING

A. **Factory Testing:** All major system components shall be factory tested for compliance with the construction and functional requirements specified herein. Certification of the test results shall be submitted in writing to the Contractor for each module and control panel separately, prior to shipment.

B. **Acceptance Testing:**

1. Following successful completion of the upstream equipment testing, Acceptance Testing shall begin. The Supplier shall coordinate with the Contractor to prepare and submit a detailed protocol to be followed for the Acceptance Test. Acceptance Testing shall occur during plant startup and shall be coordinated with the Contractor. The Supplier is required to be on-site during the performance testing.

2. The Acceptance Test shall include, but not limited to, the verification of the following:

   a. Maximum power consumption

   b. Delivered UV dose by measuring UV intensity

3.3 START-UP AND COMPONENT VERIFICATION

A. The Contractor shall arrange to have a factory-authorized field technician to the project site for the purposes of verification and installation of the equipment and initial startup and troubleshooting.

3.4 OWNER TRAINING

A. The Contractor shall have a factory authorized field technician review the installation, operate the UV equipment using hatchery water and give 4 hrs hands-on training to the Owner.

END OF SECTION

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SECTION 46 66 64 – CLOSED VESSEL UV DISINFECTION SYSTEM

PART 1 -- GENERAL

1.1 SUMMARY

A. General: The Closed Vessel Ultraviolet (UV) Disinfection System shall include UV lamp modules, a programmable logic controller, in-channel intensity sensor systems, power distribution and data center, electrical, instrumentation and control components including spare parts and all other accessories in accordance with the requirements as specified herein.

B. The UV Disinfection System shall be U-shaped and low pressure. Like items of equipment and equipment components shall be provided by a single Supplier to ensure coordination and compatibility of equipment. The supplied UV Disinfection System shall be able to fit in the allocated space as shown in the Contract Documents.

C. The Supplier shall be responsible for detailing the interconnecting electrical and control wiring for all equipment system components furnished. All components of the UV Disinfection System shall be shipped to Site by the Supplier.

D. The dimensions of the housekeeping pad shall be coordinated to match the approved UV unit. See notes on the design drawings.

1.2 CONTRACTOR SUBMITTALS

A. General. Submittals shall be prepared and transmitted in accordance with Section 01 33 00 – Contractor Submittals.

B. Shop Drawings. The following information shall be furnished with the Shop Drawings:

1. Provide shop drawings and product literature including all pertinent information for the proposed equipment such as manufacturer, capacity, type, curves, certifications, accessories, physical and performance data including dose tables, finishes, and materials. Information shall include overall dimensions, range of operating water levels, and required clearances.

    a. Where proposed equipment would result in changes to the layout presented in the Contract Documents, provide general arrangements drawings (floor plans and elevations) to scales as shown on Contract Drawings showing revised layout to accommodate the proposed equipment.

2. Provide electrical schematics and layouts, including electrical single line diagrams, schematics diagrams, and interconnection diagrams. Operating characteristics of all electrical and control equipment including power consumption, operation voltage and amperage tolerances, and ancillary electrical services shall be provided.

C. Technical Manuals – Providing technical manual for equipment in accordance with the requirements Section 01 33 00 – Contractor Submittals.

1.3 QUALITY ASSURANCE

A. The UV systems shall be from a manufacturer that has had similar systems in the same vessel configuration with the same lamps pre-validated by a third party per USEPA UVDGM or NWRI protocol.

1.4 Warranty:

A. The Contractor shall provide a Manufacturer's written warranty that provides for full replacement of all defective lamps within the first 8,760 hours of operation.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide UV systems complete with control panel(s) and all accessories herein specified and indicated in the drawings.

2.2 PERFORMANCE AND CAPACITY REQUIREMENTS

A. The UV system design will meet the performance requirements of this Specification.

Identification No	UV-510 and UV-511
Location	Incubation Building
No. of Vessels	2
Flow Rate per Vessel (gpm)	300
Configuration	Vertical, U-Shaped
Maximum Allowable Headloss per Vessel (inches)	2
Suspended Solids (mg/L)	< 25.0
Water UV Transmittance (%/cm)	90
Minimum UV Dose (mJ/cm2) at end of lamp life	130
Fouling Factor	0.87
End of Lamp Life Factor	0.8
Automatic Wiping System	Yes

2.3 DESIGN, CONSTRUCTION AND MATERIALS

A. General

1. General

2. All metal components in contact with water shall be Type 316L stainless steel.

3. All material exposed to UV light shall be Type 316L stainless steel, Type 214 quartz, HDPE, or Teflon.

4. All wiring exposed to UV light shall be Teflon coated.

B. Lamp Array Configuration

1. The lamp array configuration shall be vertical arrays with all lamps parallel to each other and parallel to the direction of flow.

2. The system shall be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the water stream. Both lamp electrodes shall operate at the same temperature and be cooled by the water stream.

C. UV Lamps

1. Lamps shall be low pressure high output, mercury amalgam type lamps.

2. UV lamps shall have a monochromatic spectral output, with the emissions peaking at 254 nanometers.

3. The type of quartz used for lamp manufacture shall be compatible with wavelength emission.

4. The operating skin temperature of the UV lamp shall not exceed 130°C.

5. UV Lamps shall not require a cool down period prior to lamp re-start, should the power to the UV system fail or be interrupted for a short period of time.

6. The filament shall be significantly rugged to withstand shock and vibration.

D. Lamp End Seal and Lamp Holder

1. Each lamp shall be enclosed in its individual quartz sleeve, one end of which shall be closed and the other end sealed by a lamp end seal and compressed O-ring. The seal shall be waterproof. The O-ring compression mechanism shall require no special tools for installation or removal.

2. The quartz sleeve shall be held in-place by means of a UV resistant retaining cup. The quartz sleeve shall not come in contact with any stainless steel frame. The lamp holder shall also incorporate a UV resistant plastic cup that shall prevent the lamp sleeve from touching the steel sleeve cup

3. In the event of a quartz sleeve fracture, the seals of the lamp holder shall prevent moisture from entering the lamp module frame and the electrical connections to the other lamps in the module.

E. UV Lamp Sleeves:

1. Clear fused quartz tubing, closed at one end shall be used. Type 219 quartz shall be used for disinfection and ozone destruction applications. Type 214 quartz also allowed.

2. Lamps shall be removable with the quartz sleeve remaining in place.

F. Automatic Wiping System

1. Provide each module with an automatic quartz sleeve wiping system, operated by the PLC control system.

G. UV Intensity Monitoring:

1. Each UV module shall have a minimum of one (1) on-line UV intensity sensor and transmitter which responds to the germicidal portion of light as measured at 253.7 nm. The sensor shall not degrade after prolonged exposure to UV light.

2. The unit shall continuously monitor the average UV intensity in the water to be disinfected and shall transmit a 4-20 mA signal to the Programmable Logic Controller (PLC), for display via the operator interface as an absolute value in mW/cm2. The accuracy shall be ± 2% of full scale transmission. The resolution shall be ± 1% of full scale transmission.

3. Initial calibration as well as calibration instructions and necessary equipment for the calibration of the UV intensity sensor shall be supplied by the Supplier. The Supplier shall field calibrate the sensor as required, using a UV transmittance monitor. The Supplier shall otherwise factory calibrate the UV intensity sensor.

H. Temperature and Alarm Monitoring:

1. The Supplier shall supply means to protect each UV vessel from over temperature, or other damaging conditions caused by loss of water flow, overheating, etc. The unit shall signal appropriate alarms to the SCADA system.

I. Electrical Components:

1. Each UV reactor shall be powered from a remote mountable System Control Center by means of a waterproof cable interfacing with a watertight strain relief.

2. The System Control Center shall be of painted steel construction.

3. Provide transformers from the UV manufacturer if system requires voltage other than the site voltage scheduled on the Drawings.

J. Control and Instrumentation

1. System control shall be microprocessor based. Operator interface is to be display type only and be located indoors.

2. The local displays main screen shall allow the operator to view current system operating statuses; providing information inclusive of: UV intensity, UV dose, system operating hours, total number of lamps operating, power level of ballasts, and any alarm conditions. Display shall allow the operator to further view alarm conditions and history, system configuration/settings, and operation.

3. Controller shall be capable of taking in a 4-20 mA input proportional to flow in gallons per minute. Controller shall calculate dose given flow and its own intensity and shall display dose and controller shall allow user to set a low dose alarm

K. Alarm Conditions:

1. The microprocessor based local display shall allow the operator to access and view the following alarm conditions:

a. Individual lamp failure – failed lamps shall be indicated by specific address (i.e. lamp #). Position in the reactor shall be indicated via lamp numbers fixed to the lamp wiring at the service end of the UV reactor.

b. Lamp life status – at the end of UV lamp(s) lifetime the elapsed time meter will flash continually for the next 240 hours to alert the operator that all lamps in the reactor require change out. A lamp life status indicator light that changes from green to orange or red for operator attention is also acceptable.

L. Alarm Signals:

1. System shall have a normally open contact so that an alarm condition can be remotely sensed.

2.4 SPARE PARTS

A. The following spare parts shall be furnished as part of the equipment supply package.

1. 50% of Total Number of UV Lamps provided

2. 50% of Total Number of Quartz Sleeves

3. 10% of Total Number of Electronic Ballasts with plug-in connectors

4. One (1) UV Intensity Sensor

2.5 MANUFACTURERS OR EQUAL

A. PR Aqua

B. Innovasea Land Systems

C. Integrated Aqua

PART 3 -- EXECUTION

3.1 GENERAL

A. The Supplier shall submit to the Contractor equipment installation instructions a minimum of 28 Days before installation begins.

B. Equipment shall have necessary means for lifting the components into place. Components shall be lubricated at the factory as necessary to protect the equipment during shipment and storage. The UV Supplier shall be responsible for terminating all connections from the PDDC and PLC to the UV modules.

C. Contractor shall install the UV Systems per the Equipment Manufacturer's directions and the project Drawings. The Contractor will provide all required supports and anchoring required to install the UV units. The Equipment Manufacturer will provide adequate crating and protection of the UV Systems for shipment to the project site. Installation instructions will be provided that specifically outline installation of the UV system. Lifting instructions will be provided to assist the Contractor in placing the units in the mechanical room.

3.2 TESTING

A. **Factory Testing:** All major system components shall be factory tested for compliance with the construction and functional requirements specified herein. Certification of the test results shall be submitted in writing to the Contractor for each module and control panel separately, prior to shipment.

B. **Acceptance Testing:**

1. Following successful completion of the upstream equipment testing, Acceptance Testing shall begin. The Supplier shall coordinate with the Contractor to prepare and submit a detailed protocol to be followed for the Acceptance Test. Acceptance Testing shall occur during plant startup and shall be coordinated with the Contractor. The Supplier is required to be on-site during the performance testing.

2. The Acceptance Test shall include, but not limited to, the verification of the following:

   a. Maximum power consumption

   b. Delivered UV dose by measuring UV intensity

3.3 START-UP AND COMPONENT VERIFICATION

A. The Contractor shall arrange to have a factory-authorized field technician to the project site for the purposes of verification and installation of the equipment and initial startup and troubleshooting.

3.4 OWNER TRAINING

A. The Contractor shall have a factory authorized field technician review the installation, operate the UV equipment using hatchery water and give 4 hrs hands-on training to the Owner.

END OF SECTION

1 Project Overview

The purpose of this document is to provide summaries and descriptions of the equipment, functions, and intended controls for each of the major features proposed for this project. This control philosophy is intended to be a guide for a qualified system integrator to develop programming logic and does not include every feature and function that will ultimately be required for successful project startup and integration. We encourage a collaborative approach to developing the best possible outcomes.

1.1 Project Summary

The Tulalip Tribes of Washington (Tribes) operate and manage salmon production facilities on Tulalip Indian Reservation land located west of the City of Marysville in the west-central part of Snohomish County, Washington. The Tribes are planning to construct a new Chum salmon rearing facility in the lower reaches of Battle Creek near the confluence with Tulalip Bay. The hatchery site is located on the right bank of Battle Creek, near the intersection of Wesley Charles Lane and Totem Beach Road. There is an existing diversion dam in the creek used to create an in-river holding pond and spawning facilities for returning adults. The remainder of the site is currently forested and undeveloped. The fish production program at the Battle Creek Hatchery is based on an annual production goal of up to 6,000,000 (6M) Chum salmon and includes incubation in vertical tray incubators in a new incubation building, grow-out in circular rearing tanks, a new surface water intake, hatchery well, and final rearing and release from the existing in-stream rearing pond on Battle Creek.

This document provides and overview of the process control philosophy that will be used for the project including the following:

- Hatchery production well(s)
- Pumped surface water intake in Battle Creek Pond
    - New structure with three submersible pumps (and space for a fourth) with VFDs,
    - Fish screens with an automatic cleaning system
- Water supply headbox
    - New structure with equipment including packed column aerators, filtration using drum filters, and ultraviolet disinfection to treat raw surface water
    - Distribution chamber for surface water
    - Storage reservoir for well water
- Incubation building
    - Incubation stacks and kitoi boxes,
    - Egg picking trough,
    - Formalin treatment piping (barrels and pumped feed system by owner)
    - Chilled water system for otolith marking,

    - Additional filtration and UV disinfection for surface water and reuse water use in incubation,
    - Formalin holding tank, metering and pumps,
    - Booster pumps for water reuse.
- Circular rearing tanks, dual-drain style
    - 10 individually metered outdoor circular rearing tanks (26-foot diameter).
- Effluent treatment drum filter
- Wastewater clarifier
    - 20-foot diameter circular clarifier with rake.

This Control Philosophy provides a brief discussion and guidance to the programmer in the functional requirements of the control system. These include descriptions of how the control system must monitor and regulate the process, react to operator input and changing process conditions. This control philosophy is intended to be a guide for a qualified system integrator to develop programming logic and does not include every feature and function that will ultimately be required for successful project startup and integration. This document will be updated as needed throughout construction and operation.

The Contractor shall produce a control narrative based on the equipment supplier control information, control philosophy and programming requirements.

1.2 Process Flow Overview

The Battle Creek Hatchery will obtain its flow from both a surface water intake located in the Battle Creek Pond, and wells. Well water will be pumped (P-201) from existing Well #1 on site to a well water storage tank at the water supply headbox after passing through a packed column aerator (PCA-201). Well water will only be distributed to the incubation building.

Surface water will be pumped from three submersible pumps (P-301, P-302, P-303) to a raw water treatment system at the water supply headbox. Surface water will discharge at the top of four packed column aerators (PCA-401, PCA-402, PCA-403, PCA-404) flow downwards by gravity into a sump containing three (3) microscreen drum filters (DF-401, DF-402, DF-403). Drum filters will remove fine solids and prepare the water for UV disinfection via three (3) open channel UV lamp banks (UV-401, UV-402, UV-403). Disinfected water will enter a chamber at the downstream end of the structure with slide gates for distribution to the site. The headbox is a rectangular concrete structure that receives water and provides control functions for the pumped surface water and is used to distribute the water to the circular rearing tanks, the incubation building, or to the wastewater clarifier. Surface water will mainly supply the circular rearing tanks, but occasionally may be used in place of well water in the incubation building.

The outflow from the well water storage tank is routed directly to the incubation building for use in vertical incubation stacks (I-1 to I-128) and Kitoi boxes (K-1 to K-12). The vertical incubation stacks are initially planned to have 8 trays per stack but are designed to be expandable to 16 trays per stack in the future. The Kitoi boxes are intended to be used for excess or surplus eggs and will be connected to a small holding tank (FT-1) with ability to transfer to circular rearing tanks using flexible hose. Well water is intended to be the primary water supply for incubation, but surface water is also available from the headbox. Well water will flow by gravity from the well water storage tank, into a common supply trough that will deliver water to the two row supply troughs that distribute water to two rows of incubation stacks each. A chiller system (CHS-500) is also included for use in otolith marking.

A formalin treatment system for the incubation building is intended to be installed in the future by others (Washington Department of Fish and Wildlife) and will be connected to the incubation stacks and, if desired, the Kitoi boxes. When formalin is used, valves are provided on the drain sumps from the incubation stacks to redirect the effluent into a formalin holding tank (T-540) that has a pump (P-540) to slowly pump out the water to meet label dilution requirements.

Water supply, chilled water, and formalin will be collected in a drain sump beneath the incubation stacks. Effluent can be sent to either the formalin metering tank (when formalin is being used) or to the incubation reuse pump station wet well.

Surface water supply to the incubation building will require additional screening prior to use in incubation stacks to prevent smothering of the eggs. Surface water will be discharged into the reuse pump station along with the effluent from the egg trays and pumped (P-530 and P-531) through a screen filter skid (SF-510) with a 10-micron filter through low-pressure closed vessel UV units (UV-510 and UV-511), and then to a packed column aerator (PCA-510) before being distributed to the incubation stacks via the main supply trough. Operating pressure required for the equipment will be maintained with a pressure regulating valve (PRV-510).

Surface water will mainly be distributed to the circular tanks (T-601 through T-610). The circular rearing tanks are Cornell-style dual drain style, 26-ft diameter, with a single water supply pipe manifold and two drain outlets, one on the bottom and the other on the side wall. Water will flow by gravity from the headbox to tanks that are in service. Each tank will have a flow meter (FM-601 to FM-610) on the supply pipe. Effluent can be routed to three locations:

- Side-box effluent to Battle Creek Pond,
- Side-box effluent to Battle Creek (downstream of the diversion structure),
- Bottom drain effluent to the effluent drum filter and wastewater clarifier.

The side box outlet captures the cleaner effluent and may be routed to either to the Battle Creek Pond or Battle Creek below the diversion structure using a standpipe assembly. The bottom drain is directed to the clarifier tank for solids removal prior to discharge below the diversion structure. A fish release pipe is also connected out of the center drain to allow fish to be moved directly out to Battle Creek Pond without handling.

Concentrated backwash/overflow from the drum filters in the water supply headbox (DF-401, DF-402, DF-403), from the screen filter skid in in the incubation building (SF-510), and from the chiller skid (CHS-500) are routed directly to the clarifier tank (CFR-701). Effluent from the circular tank bottom drains is first routed to an effluent drum filter (DF-701) and the backwash is then routed together with the other backwash/overflow to the clarifier tank. Effluent reaching in the wastewater clarifier will have a retention time of approximately 10-minutes to allow larger solids such as fish waste or excess feed to settle. Clean water will discharge downstream of the Battle Creek diversion structure. Solids accumulated on the bottom of the clarifier will be collected in the center chamber. From this chamber, a pipe with a camlock fitting will come up above grade where a truck can access the clarifier and pump out waste.

2 Well Water Supply

The well water supply system consists of an existing production well (Well #1) with capacity to add a future well. Well water is pumped to a packed column aerator (PCA-201) located above the well water storage tank at the water supply headbox .

2.1 Production Well

The production well is located in the northeast corner of the project site and is accessible off of Wesley Charles Lane. A well screen and casing was installed in 2020. The well is 175 feet deep, has a 12-inch diameter casing with 20 feet of 8-inch well screen from 154-174 feet below ground surface (bgs) and the casing. A 72-hour step test performed in 2020 by Keta Waters estimated the well to have a long-term yield of approximately 200 gpm.

The submersible well pump (P-201) is designed for 250 gpm flow and 250 feet of total dynamic head (TDH).

Features of this item include the following:

- Submersible well pump P-201 with VFD-P-201
- Pit-less adapter assembly
- Level indicating transmitter LIT-2101 installed in the casing
- Valve vault that includes:
    - Pressure gauge PI-2101 and pressure indicating transmitter PIT-2101
    - Check valve CV-201

Control Functions:

- Water level in the well casing is monitored and recorded by LIT-2101.
- When the level in the well casing reaches an adjustable low-level set point LAL-2101, an alarm is generated at the SCADA level.
- When the level in the well casing reaches a low-low setpoint LALL-2101, the pump P-201 is shutdown to prevent dry run, and an alarm is generated at the SCADA level.
- Operation of the well pump P-201 is controlled by a dedicated variable frequency drive VFD-P-201 in response to automatic controls, local manual controls, or remote SCADA commands.
- When the water level in the well water storage tank at the water supply headbox as indicated by LI-2102 reaches a low-low setpoint LALL-2102 or high-high setpoint LSHH-2102, an alarm is generated at the SCADA level. In addition, the triggered level switch LSHH-2102 shuts off the well pump P-201 and incubation reuse pumps P-510 and P-511.
- When in AUTO mode Loop 1 - Flow Rate, the pump speed is adjusted by a VFD to maintain an adjustable WELL WATER FLOW SET POINT measured by flow meter FM-201. The VFD speed shall also be manually adjustable by the SCADA.
- When in AUTO mode Loop 2 - Well Water Storage Tank Level Maintenance, the pump is automatically started and stopped based on water level in the well water storage tank. When the level in the Well Water Storage Tank reaches low-level set point LSL-2101 the pump will run. When the level reaches high-level set point LSH-2101, the pump is shut off.
- Discharge flow rate of the well pump P-201 is monitored and recorded by flow meter FM-201. Any alarm condition from the flow meter transmitter is returned to the SCADA.
- Well Water Storage Tank level override - When running simultaneously with the incubation reuse pumps (P-530 or P-531), the well pump will run continuously WHEN the flow rate measured by FM-201, FM-202, or combination thereof, exceeds the WELL WATER FLOW SET POINT.
- Discharge pressure of the well pump P-201 is monitored by the pressure gauge PI-2101 and the pressure transmitter PIT-2101. When a high-pressure setpoint PAH-2101 or a low-pressure setpoint PAL-2101 is achieved, an alarm is generated at the SCADA level.

- The well pump control panel returns pump run status, alarms, and faults to the SCADA.
- The well pump motor has winding high temperature protection that stops motor operation via controls in the VFD when high temperature occurs.
- The well pump motor has a moisture sensor that stops motor operation via controls in the VFD when moisture is detected.
- VFD Level:
    - VFD-2-P-01 has an Operator Interface with the controls and displays PUMP SPEED (SI), VFD FAIL (YA) alarm and shutdown, RUN status (YI), MOTOR HIGH TEMPERATURE (TSH) alarm and shutdown, MOTOR MOISTURE (MSH) alarm and shutdown.
    - Pressing of the reset button (HMS) is necessary to resume operation after a shutdown alarm.
    - When the HAND/OFF/AUTO (HS) switch is in the HAND position, the operator manually controls pump operation by using the START/STOP (HS) switch, and the manual speed control (SC) at the VFD Operator Interface.
    - When the HAND/OFF/AUTO switch (HS) is in the AUTO position, VFD manual control is disabled.
- AUTO mode (two loops) for the well pump P-201:
    - Loop 1 - Flow Rate: When the mode selector is in "AUTO" the plant PLC will automatically start/stop pump and increase/decrease its speed to maintain the operator setpoint WELL WATER FLOW SETPOINT as measured by the flow meter FM-201. The PLC will start pump at an adjustable minimum speed (initially set at 40 Hz) and then the pump shall modulate to keep the flowmeter output within an adjustable dead band of the setpoint (initially 2.5% dead band). The modulating range of the well pump P-201 is within 190 - 210 gpm.
    - Loop 2 - Well Water Storage Tank Level Maintenance: The purpose of the well water storage tank is to hold a defined volume of water (approximately 24,000 gallons) to feed the incubation building in the event of a power outage. To ensure the required volume of water is always available in the well water storage tank, it is necessary to maintain a 71.50-ft water level in this tank. The 71.50-ft water level is an adjustable level setpoint in the well water storage tank.
        - The well water storage tank is fed by the well pump P-201 and the incubation reuse pumps P-510 and P-511 (incubation reuse water).
        - The speed of the well pump P-201 is adjusted by the VFD-P-201 to maintain the 71.50-ft water level in the well water storage tank.
        - If the water level inside the well water storage tank as measured by LIT-2102 is below the 71.50-ft water level setpoint, the PLC will speed up the well pump P-201 until the water level achieves the 71.50-ft water level setpoint.
        - If the water level inside the well water storage tank as measured by LIT-2102 is above the 71.50-ft water level setpoint, the PLC will slow down the well pump P-201 until the water level drops to the 71.50-ft water level setpoint.
        - The well pump P-201 is automatically started and shut down on achievement of low-level setpoint LAL-2102 and high-level setpoint LAH-2102 correspondingly in the well water storage tank.
        - Once the water level drops to the low level setpoint LAL-2102, the well pump P-201 will start with an adjustable minimum speed (initially set at 40 Hz) and then the pump shall modulate to achieve the 71.50-ft water setpoint again.

- Once the water level reaches the high level setpoint LAH-2102, the speed of well pump P-201 will be reduced using VFD-P-201 until the 71.50-ft water level setpoint is achieved.
- If well pump P-201 reaches the adjustable minimum speed but is still above the 71.50-ft water level setpoint, it will shut off until triggered by low water level LAL-2102 to restart.

2.2 Well Water Storage Tank

The well water storage tank is a rectangular concrete basin dedicated for well water operations at the water supply headbox. The tank creates a reservoir of aerated well water with a total volume of 24,000 gallons, sufficient to provide approximately 30 minutes of storage for the incubation building following a power outage or mechanical equipment issue. The structure has one packed column aerator with supports for a future second aerator (PCA-201) mounted at the top that serve to aerate and degas well water.

Gravity water flowing from the well water storage tank primarily supplies the incubation building but may also be overflow to the surface water side of the headbox to supplement the surface water inflow. The valve configurations in bypass mode are discussed in the previous section.

Features of this item include the following:

- Well water packed column aerator PCA-201
- Dissolved oxygen analyzer AIT-2101 and temperature reader
- Float switch LSHH-2102 for water high-high level control
- Level indicating transmitter LIT-2102 for control of the well pump P-201 and water level
- Flow meter (FQIT-2101) for flow monitoring of the well pump P-201
- Well water supply isolation valve BFV-201

Control Functions:

- A dissolved oxygen analyzer AIT-2101 monitors the dissolved oxygen and water temperature in the headbox. The triggered low level of dissolved oxygen generates an alarm at the SCADA level.
- Float switch LSHH-2102 and level indicating transmitter LIT-2102 provide adjustable points for four water elevations: LOW-LOW (LALL-2102), LOW (LAL-2102), HIGH (LAH-2102), and HIGH-HIGH (LAHH-2102).
- The normal operating range in the tank is between the LOW and the HIGH float switches. If AUTO mode, the PLC executes modulation of the speed of the well pump P-201 according to the control logic of the activated control loop (see Production Well).
- The triggered HIGH-HIGH setpoint automatically shuts down the well pump P-201.
- Triggering the LOW-LOW or HIGH-HIGH set point generates an alarm at the SCADA.
- The distribution from the well water storage tank to the incubation building and is implemented by manual adjustment of the butterfly valve, BFV-501, at its point of use in the Incubation Building. Outflow from the well water tank to the incubation building is monitored and recorded by flow meter FM-501 in the incubation building. The flow rate set point shall alarm at an adjustable deadband (initial 2.5%) around the set point. Any alarm condition from the flow meter transmitter is returned to the SCADA.
- Overflow from the well water storage tank is spilled into the water supply headbox.

3 Pumped Intake

The intake pump station is located on the right bank of Battle Creek just upstream of the existing diversion dam. The station consists of intake structure with intake screens, a wet well with three submersible intake pumps, a valve vault, and an overflow weir gate that releases water to Battle Creek below the diversion dam.

3.1 Intake Screening

Intake screening to prevent fish entrainment in the hatchery water supply consists of two (2) cylindrical rotating wedge wire fish screens (SC-301, SC-302) that draw water from the reservoir. The intake screens have a rotation that turns the screens and are equipped with a stationary brush cleans the screen during rotations. The cleaning system initiates automatically based on differential measured across the screens. Measurement of the difference in water levels between the front and the back of the screen determines the degree of screen occlusion and initiates the cleaning of the screen when necessary. Knife gate valves (KGV-301, KGV-302) located on the downstream side of the intake screens are used to isolate flow through the screens. The intake screen may be removed for maintenance using a hoist mechanism mounted above the screens at the top of the structure.

Control Functions:

- Each intake screen is provided with a local control panel LCP-SC-301 and LCP-SC-302 with connections to the plant programmable logic controller (PLC) and a touchscreen HMI interface.
- Each intake screen operates independently (HAND/OFF/AUTO) based on differential measured within the unit or on a programmed frequency:
    - An automatic cleaning cycle will be triggered based on the factory-programmed frequency (3 cleaning cycles per day each with a duration of 60-seconds in a forward direction, a 3-second stop, and 60-seconds in the reverse direction).
    - An automatic cleaning cycle can also be set to trigger based on operator-desired criteria such as pressure differentials or flood events.
    - Over-torque switch to reverse screen and move forward to dislodge debris (maximum of 3 attempts to clear debris before issuing a fault and stopping the screen)
    - Manual cleaning cycles can be initiated in HAND mode at LCP-SC-301 and LCP-SC-302.
        - Cylinder rotation can be controlled at the plant LCP with the following options:
        - FWD/OFF/REV: Three-position selector switch with spring-return to center type operator to engage rotation of the screen cylinder in the designated forward or reverse direction.
- The cleaning cycle for each intake screen may be initiated remotely by the PLC.
- The knife gate valves and the hoist removal mechanisms have no control functions in the PLC.

3.2 Intake Pump System

Surface water supply through the intake screens SC-301 and SC-302 is directed into a rectangular wet well pump station with three (3), and ultimately four (4), submersible intake pumps P-301, P-302, P-303 (P-304 future) rated for 2400gpm with a total dynamic head (TDH) of 80-feet. The pumps will operate as duty/standby to provide redundancy in the event of a pump failure or so that hatchery operations can continue during servicing of a pump. The maximum combined flow is understood to be 7200gpm. All pumps (P-301, P-302, P-303, and P-304) will have VFDs included to accommodate pump cycling. The pumps are controlled by VFDs and the pump speed and number of pumps in service will vary based on the water supply availability in the creek and water demand at the hatchery.

Each pump will be provided with a local control panel (LCP) with LOR switches. The status of the pumps and the water levels in the intake structure will be monitored and controlled by the plants main PLC via the SCADA system.

Features of this item include the following:

- Level indicating transmitter LIT-3201 for water control in the intake wet well
- Each individual discharge line of the intake pumps P-301, P-302, P-303 includes the following items located in the intake pump station valve vault:
    - Pressure indicator PI-3201, PI-3202, PI-3203 and pressure indicating transmitter PIT-3201, PIT-3202, PIT-3203
    - Air release valve ARV-3301, AVR-3302, ARV-3303
    - Check valve CV-301, CV-302, CV-303
    - Low flow detection switch FSL-3301, FSL-3302, FWL-3303
    - Butterfly valve BFV-301, BFV-302, BFV-303

Control Functions:

- Float switch LSLL-3201 and level indicating transmitter LIT-3201 track four water elevations in the intake wet well: LOW-LOW (LALL-3201), LOW (LAL-3201), HIGH (LAH-3201), and HIGH-HIGH (LAHH -3201).
- The triggered LOW (LALL-3201) setpoint in the intake wet well generates an alarm at the SCADA level.
- The triggered LOW-LOW (LALL-3201) setpoint in the intake wet well automatically shut down the intake pumps P-301, P-302, P-303 to prevent their dry run and generates an alarm at the SCADA level (for all scenarios and control loops).
- The triggering HIGH-HIGH (LAHH -3201) setpoint in the intake wet well generates an alarm at the SCADA level.
- Operation of each intake pump P-301, P-302, P-303 is controlled by a dedicated Variable Frequency Drive VFD-P-301, VFD-P-302, VFD-P-303 correspondingly in response to local manual controls, or remote SCADA commands.
- Each pump motor has winding high temperature protection that stops motor operation via controls in the VFD when high temperature occurs.
- Each pump motor has a moisture sensor that stops motor operation via controls in the VFD when moisture is detected.
- A low flow detection switch FSL-3301, FSL-3302, FSL-3303 is mounted on each discharge pipeline to stop the correspondent intake pump P-301, P-302, P-303 via control in the VFD if a low flow setpoint is triggered while the pump is running.
- A pressure indicator PI-3201, PI-3202, PI-3203 measures and indicates discharge pressure of the intake pump P-301, P-302, P-303 correspondingly.

- VFD Level:
    - Each VFD has an Operator Interface with the controls and displays PUMP SPEED (SI), VFD FAIL (YA) alarm and shutdown, MOTOR HIGH TEMPERATURE (TSH) alarm and shutdown, MOTOR MOISTURE (MSH) alarm and shutdown, and DISCHARGE LOW FLOW (FAL) alarm and shutdown.
    - Pressing of the reset button (HMS) is necessary to resume operation after a shutdown alarm.
    - When the HAND/OFF/AUTO (HS) switch is in the HAND position, the operator manually controls pump operation by using the START/STOP (HS) switch, and the manual speed control (SC) at the VFD Operator Interface.
    - When the HAND/OFF/AUTO switch (HS) is in the AUTO position, VFD manual control is disabled.

- AUTO mode (3 control loops):

- Loop 1 – Flow Rate: When the mode selector is in “AUTO” the plant PLC will automatically start/stop intake pump(s) and increase/decrease their speed to maintain the operator-adjustable INTAKE FLOW RATE set point as measured by summation of flow meters FM-401. The PLC will start pump(s) at an adjustable minimum speed (initially set at 40 Hz) and then the pump(s) shall modulate to keep the flowmeter output within an adjustable dead band of the setpoint (initially 2.5% dead band).

  If the flow setpoint is from 0 – 2,400 gpm the PLC will run one pump, if it is from 2400 – 4800 gpm the PLC will run two pumps, and for 4,800 gpm and above it will run three pumps. Each running pump will operate at the same speed.

- Loop 2 - Y-Water Level Maintenance in the Intake Wet Well. During the periods with deficiency of water in Battle Creek, the Operator can select the control loop 2 to feed the hatchery system based on availability of surface water in the intake wet well and fluctuation of the surface water inlet.

  In this case, the PLC will maintain Y-water level in the intake wet well measured by LIT-3201. If the water level inside the intake wet well as measured by LIT-3201 is below the Y-water level setpoint, the PLC will slow down the intake pump(s) until the water level rises to the Y-water level setpoint. If the pump(s) reach the minimum speed setpoint for longer than an adjustable time delay setpoint the PLC will stop one pump at a time. The PLC will then automatically adjust speed of the remaining pump(s) to maintain the water level at the low level setpoint.

  If the water level inside the intake wet well as measured by LIT-3201 is above the adjustable Y-water level setpoint, the PLC will speed up running pump(s) until the water level in the intake wet well achieves the Y-water level setpoint. If the pump(s) reach the maximum speed setpoint for longer than an adjustable time delay setpoint but the Y-water level setpoint is still not achieved, the PLC will start one more pump at a time. The PLC will then automatically adjust speed of the running pumps to maintain the Y-water level setpoint.

- Loop 3 - Z-Water Level Maintenance in the Headbox: Purpose of this loop is to maintain a constant water level in the headbox to feed the circular rearing tanks and other components of the hatchery if needed.

  The headbox primarily feeds the circular rearing tanks, and, if needed, the incubation building, by gravity driven surface and reuse water. For a uniform gravity water supply, it is necessary to maintain a constant Z-water level in the headbox.

  During normal operation, the headbox is fed by the intake pumps P-301, P-302, and P-303. Operation of each intake pump P-301, P-302, P-303 is controlled by a dedicated Variable Frequency Drive VFD-P-301, VFD-P-302, VFD-P-303 correspondingly in response to manual commands or by the PLC’s running control loop.

  Z-water level is adjustable water level setpoint located between LOW and HIGH setpoint in the headbox as measured by level indicator LI-4101 and transmitted by level indicating transmitter LIT-4101.

  In order to maintain the Z-water level in the headbox, the PLC adjusts speed of the intake pumps P-301, P-302, P-303 based on measurements of LIT-4101 in the headbox.

  If the water level inside the headbox as measured by LIT-4101 is below the Z-water level setpoint, the PLC will speed up the intake pump(s) until the water level rises to the Z-water level setpoint. If the intake pump(s) reach the maximum speed setpoint for longer than an adjustable time delay setpoint but the Z-water level is still not achieved, the PLC will start

one more intake pump. The PLC will then automatically adjust the speed of the running pumps to maintain the Z-water level at the headbox.

If the water level inside the headbox as measured by LIT-4101 is above the Z-water level setpoint, the PLC will slow down the intake pump(s) until the water level drops to the Z-water level setpoint. If the pump(s) reach the minimum speed setpoint for longer than an adjustable time delay setpoint the PLC will stop one pump at a time. The PLC will then automatically adjust the remaining pump(s) speed to maintain the Z-water level in the headbox.

The intake pumps P-301, P-302, P-303 are automatically started up on achievement of HIGH setpoint LAH-4101 in the headbox.

Once the water level drops to the LOW level setpoint LAL-4101 in the headbox, one intake pump will be started with an adjustable minimum speed (initially set at 40 Hz) and then the intake pump shall modulated to achieve the Z-level setpoint.

The intake pumps P-301, P-302, P-303 are automatically shut down on achievement of HIGH-HIGH setpoint LAHH-4101 in the headbox and an alarm is generated at the SCADA level.

Once the water level reaches the HIGH-HIGH level setpoint LAHH-4101, all running intake pumps P-301, P-302, P-303 will be stopped until the triggered HIGH water level LAH-4101 restarts one intake pump again.

- The pumps will alternate as Lead, Lag or Standby status.
- If either the Lead or Lag pump fails, the Standby pump shall be started to take the place of the failed pump.
- When the speed of the combined pumps reaches a low speed adjustable setpoint the pumps will be decoupled, and the Lag pump shall be ramped down and stopped and the Lead pump shall continue to track the flow setpoint.
- MANUAL mode: when the mode selector is in "MANUAL" the operator will manually start and stop pumps and adjust their speed setpoint (one for each pump). The PLC will automatically restart pumps after a power interruption to match their on/off and speed setpoints before the interruption.
- Alarms: Should a pump fault/failure occur, the pump will be removed from the pumping sequence. This includes pumps that are actively running. Alarm acknowledgements are required to put the pump back into the sequence. If the alarm condition is still active, the alarm will generate again, and the pump will remain out of sequence. Additionally, the faulted pump will require a reset / acknowledge of the alarm, which can be done by clicking the acknowledge / reset button on the affected pump popup on the HMI / SCADA, or by clicking the global acknowledge all alarms button in the top banner of the facility's HMI / SCADA screen.

3.3 Diversion Structure Bypass and Overflow

An overflow weir gate (G-301) in the intake wet well is used to bypass the river flows from spilling over the dam, when desired to prevent fish in the Battle Creek pond from escaping over the dam boards. The weir gate is adjustable up and down to maintain target level of spill. The gate is intended to be closed (up position) when spill over the diversion structure is allowable and opened (down position) at times when fish are in the reservoir and it is preferred to screen the water prior to discharge below the structure.

Control Functions:

No control functions from the plant PLC.

4 Water Supply Headbox

The water supply headbox consists of two parts: (1) a well water storage tank and (2) surface water treatment and distribution. The well water storage tank will have one packed column with supports in place for a second (PCA-201) at the top of the structure for degassing/aeration. One of the packed columns is intended to service fresh well water from P-201 (PCA-201), the second column (PCA-202) will service fresh well water from a future second well. Each aerator is sized for approximately 60gpm/sf based on flow rates of 500gpm. A flow meters is placed on the supply pipe to the aerator (FM-201). **See Section 2.2 Well Water Storage Tank.**

The surface water treatment area will have four (4) packed columns aerators (PCA-401, PCA-402, PCA-403), three (3) drum filters (DF-401, DF-402, DF-403), and three (3) UV reactors (UV-401, UV-402, and UV-403). The packed columns will degas and partially aerate water pumped from the surface water intake (P-301, P-302, P-303). The water will then be treated for solids removal by the drum filters, followed by disinfection at the UV units. Treated water will be stored in the headbox and distributed throughout the site by manually operated slide gates (G-401, G-402, G-403, and G-404) to the following destinations: (1) the incubation (2) the circular rearing tanks T-601 to T-605, (3) a structure drain to the clarifier (CFR-701) or (4) the circular rearing tanks T-606 to T-610. An overflow weir and pipe are also present to control water level in the headbox that returns water to Battle Creek Pond.

4.1 Packed Column Aerators – Well Water

Packed columns for well water are sized to be 3-feet diameter and 5-feet tall. Pumped water will be distributed at the top of the column through a perforated plate for even distribution drained by gravity through the media of the column into the well water storage tank. See **Section 2.2 Well Water Storage Tank** for other instrumentation.

Control Functions:

- The flow to individual packed column aerators PCA-201 and PCA-202 (future) will be isolated using a manual butterfly valve.
- Flow meter FM-201 will be used to monitor flow from the well pump and incubation reuse pumps.
- No control functions from the plant PLC.

4.2 Packed Column Aerators – Surface Water

Packed columns for surface water (PCA-401, PCA-402, PCA-403, PCA-404) are sized to be 5.5-feet diameter and 8-feet tall. Pumped water (P-301, P-302, P-303) will be distributed at the top of the column through a perforated plate for even distribution drained by gravity through the media of the column into the surface water storage tank.

Control Functions:

- The flow to individual packed column aerators will be isolated using a manual butterfly valve: BFV-401, BFV-402, BFV-403, BFV-404.
- No control functions from the plant PLC.

4.3 Drum Filters

Each drum filter (DF-401, DF-402, DF-403) is sized for 2400gpm of flow and can be isolated via stoplogs upstream of each drum.

Each drum filter is provided as a vendor package. Each will have its own control panel (LCP-DF-401, LCP-DF-402, LCP-DF-403) and is controlled as an independent system by the PLC. The three filters have sufficient redundancy to function as two duty and one standby, but they will be operated together to achieve better treatment during the normal operation.

Water flows by gravity into the center of the drum and through the filter screen modules. The water level inside the unit submerges approximately 50-65% of the screens. Solids are separated from the water as it passes through the micro screen cloth. At a predetermined differential across the screen, a backwash cycle is initiated. During the backwash, the screen rotates and is cleaned by spray nozzles. The backwash water is collected in a trough within the unit and flows by gravity to the waste cleaning ponds through a cleaning water (CW) pipe. Water for the backwash system is supplied by a pump on each drum filter and drawn from the filtered water after passing through the screen. The backwash cycle is based on a timer and a screen rotation distance. Once the timed over-run is elapsed, the backwash pump stops, and the filter returns to a stationary state until next backwash cycle is initiated.

Filtration is continuous even during the backwash cycle and the effluent water quality is also the same throughout the backwash cycle. Each unit is equipped with a back wash pump, one drum motor, a spray bar motor, and one VFD. The VFD controls the drum motor and it ramps up the drive motor to operating speed and runs as long as required by the backwash operation. The level switch installed in the inlet box is used in process control to determine the backwash elevation setting. The Plant main PLC shall be able to monitor and display the operation status of the three filters by pulling the information from the local vendor control panels.

Control Functions:

- Each drum filter operates independently (HAND/OFF/AUTO) based on differential measured within the unit.
- The backwash cycle initiates based on a timer or when triggered by water differential across the screens.
- Each drum filter will have an emergency switch located at the drum filer for emergency situations.
- Each drum filter control panels return run status (on/off), alarms, and faults to SCADA.
- The drum motor, backwash pump, and backwash spray bar for each unit shall be controlled remotely by the PLC.
- Water level in the drum filter is controlled by an internal weir. The triggered low water level (LALL-4201/4202/4203) or high-water level (LAHH-4201/4202/4203) generates an alarm at the SCADA level.

4.4 UV Disinfection

The three (3) UV units (UV-401, UV-402, UV-403) are pre-packaged units supplied by a UV vendor and includes the UV reactors, UV electrical control panel, and UV sensors. Each UV unit is sized to handle 33% of the peak flow, which is 2,400gpm.

Each lamp bank is equipped with a UV intensity sensor (UVT-110/UVI110). The UV intensity sensor is used to measure the UV intensity, which is displayed at the local control panel provided by the UV vendor, and on the SCADA system. This measured UV intensity is not used for control but used to generate a Low UV Intensity alarm at the local control panel when the measured UV intensity drops 25% (adjustable) below the theoretical UV intensity calculated by the controller.

The control panel includes a local PLC which controls the operation of the UV system. During normal operation the output of the UV vessel is varied to meet the Operator adjustable UV dosage setpoint UC-4301, UC-4302, UC-4303 (designed to be set at 60 mJ/cm^2).

Under normal operating conditions the three vessels are operating simultaneously. The power level of each bank is varied by the system, between 60 to 100% power to maintain the pre-set UV dosage.

When one of the units is required to be shut down for maintenance, the operator can request which UV vessel to be shut down from the PLC. Stop log slots are provided in the UV channel to prevent water from bypassing through the off UV unit while shut down.

The performance (Flow rate and UV dose) of the UV system shall be monitored and displayed on main plant PLC.

Similar to the other vendor supplied package, the Plant main PLC will monitor the performance and status of the UV system. If the Plant main PLC wants to take control the operation of the equipment, the appropriate digital signals and analogue speed control signals need to be wired to each machine.

Alarms will be generated at the local control panel, plant main PLC, and at the SCADA level during the situation of no flow, high temperature, unit failure, lamps broken and so on.

Control Functions:

- UV units have a limited range of operation based on water level.
    - Water level is maintained by a weir downstream of the UV units with the crest elevation at 65.00 (minimum operating WSE for UV operation).
- The total system flow shall be provided to the UV control panels to allow for UV dose pacing. With UV dose pacing, the lamp power will automatically dim down to 50% to reduce power consumption. Dimming is when the UV system automatically regulates its power level to not deliver a higher UV dose than necessary through input from the flow meter and the built-in UV intensity sensor.
- Alarms: Temperature sensors are included with the UV lamp banks and will shut the UV lamps off if temperature reads too high. Leakage alarm.

4.5 Distribution Chamber

The surface water distribution chamber in headbox is a concrete rectangular chamber that receives treated surface water . Four slide gates are available to distribute water to: (1) the incubation (2) the circular rearing tanks T-601 to T-605, (3) a structure drain to the clarifier (CFR-701) or (4) the circular rearing tanks T-606 to T-610. An overflow weir and pipe are also present to control water level in the headbox that returns water to Battle Creek Pond.

Control Functions:

- Float switch LSHH-4401 and level indicating transmitter LIT-4101 provide adjustable points for four water elevations: LOW-LOW (LALL-4101), LOW (LAL-4101), HIGH (LAH-4101), and HIGH-HIGH (LAHH-4401).
- A dissolved oxygen sensor monitors (AE/AIT-4401) the dissolved oxygen and water temperature in the headbox. The triggered low level of dissolved oxygen generates an alarm at the SCADA level.

5 Incubation

The Incubation Building is a large rectangular building the contains the following process functions:

- Egg Incubation in vertical incubation stacks (I-1 to I-64) with 8 trays (7 in use) per stack. A total of 64 x 8-tray stacks are included. There is capacity to expand with an additional 64 trays mounted above to become double stacks.
- Egg Incubation in Kitoi boxes (K-1 to K-12). A total of 12 Kitoi boxes are included.
- One egg picking troughs (E-1) for temporary holding and removal of dead eggs.
- A circular fiberglass holding tank (FT-1) on a skid to receive the hatchlings from the Kitoi boxes.
- Surface water/reuse water treatment for use in incubation, consisting of a screen filter (SF-510) with filter opening rated for 10-micron, two UV reactors (UV-510/UV-511), and a packed column aerator (PCA-510).
- A chiller system (CHS-500) for otolith marking.
- Formalin treatment system for fungal control. Piping is included but the pumps and control system are by owner.

The hatchery will feature both vertical incubation (Heath) stacks and Kitoi boxes for incubation. The vertical incubation stacks are initially planned to have 8 trays per stack but expandable to 16 trays per stack in the future.

5.1 Vertical Incubation Stacks

Control Functions:

- A level switch in the common supply trough provides a low-level alarm to the SCADA.

5.2 Kitoi Boxes

The Tribe has existing Kitoi boxes that will be installed inside the incubation building. A total of 12 boxes are planned to be installed. The Kitoi boxes are intended to be used for excess or surplus eggs and will be connected to a small holding tank (FT-1) with ability to transfer to circular tanks using flexible hose. Water supply is delivered from the well water storage tank and is controlled by a butterfly isolation valve (BFV-502) located in the room. Water discharge from the Kitoi boxes goes into an aluminum trough and is routed into a 4-ft diameter circular fry tank (FT-1). From the fry tank, an overflow stand pipe routes water to a drain trench where Kitoi boxes effluent mixes with effluent from the vertical incubation stacks, and subsequently to the incubation reuse pump station or the formalin meter tank (T-540).

Control Functions:

- No control functions in the SCADA.

5.3 Egg Picking Troughs

One 8-ft long egg picking troughs will be provided for removal of dead eggs. They operate on very little well water and can be controlled with a 1” ball valve. Water will flow from one end of the trough to another and drain into a drain funnel that discharges into the drain sump below the incubator stacks.

Control Functions:

- No control functions in the SCADA system.

5.4 Back-Pressure Sustaining Valve

A back pressure sustaining valve will be used upstream of the screen filter assembly to ensure a minimum pressure of 20psi is available at the entrance to the screen filter skid. A pressure sensor will be placed at the inlet to the screen filter skid.

Control Functions:

- The back pressure valve will adjust according to the pressure reading from PI-5401 or PI-5402 to maintain a reading of 20psi upstream of the screen filter
- Pressure readings from PI-5401 or PI-5402 will be available on the plant PLC.

5.5 Screen Filter Assembly

The screen filter assembly (SF-510) will consist of four 5-micron screen filters connected by a common manifold. Each filter will have a manual butterfly valve on the inlet an outlet pipe, and a bypass pipe with a manual butterfly valve (BFV-510) on the common manifold in the event all four screen filters are offline. The screen filters are designed to operate as duty/standby with three screens operating at a time and one on standby. The screen filters act as secondary filtration for surface water to remove smaller particles that could smother eggs in the incubator.

The screen filter features an automatic backwash system that triggers on differential build-up across the screens. Measurement of the difference in water levels between the front and the back of the screen determines the degree of contamination and initiates the cleaning of the screen. When triggered, a suction nozzle opens that pulls material off the screen. The backwash is driven by pressure difference through the suction nozzle and a separate pump is not required for backwash. Backwash from the screen filter is directed to the clarifier.

Control Functions:

- The pressure upstream of the filter is monitored in the PLC by a pressure gage and transmitter.
- Screen filters operate (HAND/OFF/AUTO) based on differential pressure measured within the unit.
- System control is dictated by the flush port pressure gauge, the inlet pressure gauge, and the backwash control
    - A flush valve opens automatically that creates a low-pressure path for suction nozzles to vacuum debris from the screen – pressure at the flush port should be minimized.
    - Backwash is automatic based on differential but can be set to a timer if desired at the LCP.
- The cleaning cycle for each intake may be initiated remotely by the PLC when the screen filters are in HAND mode.
- A back-pressure sustaining valve downstream of the screen filter pressure is modulated to maintain system pressure at or above a minimum pressure set point as measured by the pressure gage.
- Each screen filter provides running status (on/off) and failure alert back to the plant PLC.

5.6 Incubation Reuse Pump Station

The incubation reuse pump station will consist of a concrete manhole with two submersible pumps (P-530 and P-531). Each pump will have a butterfly valve and check valve on the discharge line with an air release valve at the high point . The pumps will be adjusted with VFD-P-530 and VFD-P-531 correspondingly. The pump design point is 800gpm @ 80ft TDH.

The sumps beneath the incubation stacks will collect water from the stacks, egg picking trough, and Kitoi boxes and drain by gravity into the reuse pump station or the formalin metering tank depending on whether or not formalin was used on the eggs. The reuse pump station will pump water from the sump into the mechanical room in the incubation building. The water will be filtered through a pressurized screen filter (SF-510), disinfected via UV (UV-510 and UV-511), and aerated through a packed column aerator (PCA-510). It is assumed that both pumps can be in operation if required, but normal operation involves only one pump in operation and one standby pump.

The pumps will be provided with a local control panel (LCP). The status of the pumps and the water levels in the reuse pump station will be monitored by the Plant main PLC via the SCADA system. The total required reuse flow rate can be adjusted by an INCUBATION REUSE FLOW RATE set point in the Plant main PLC.

Control Functions:

- Operation of each incubation reuse pump P-530 and P-531 is controlled by a dedicated Variable Frequency Drive VFD- P-530 and VFD- P-531 correspondingly in response to local manual controls, or remote SCADA commands.
- Discharge of the incubation reuse pumps P-530 and P-531 can be isolated with correspondent isolation valves BFV-530 and BFV-531.
- Discharge pressure of the incubation reuse pumps P-530 and P-531 is monitored by pressure gauge PI-5204 and pressure indicating transmitter PIT-5201. Once a high-pressure setpoint PAH-5204 or the low-pressure setpoint PAL-5204 is triggered, an alarm is generated at the SCADA level.
- Level switch LSHH-5203 and level indicating transmitter LIT-5203 provide adjustable points for four water elevations: LOW-LOW (LALL-5203), LOW (LAL-5203), HIGH (LAH-5203), and HIGH-HIGH (LAHH-5203) in the incubation reuse wet well.
- The incubation reuse pump P-530 OR P-531 is controlled by a correspondent reuse pump control panel.
- When the level in the incubation reuse wet well reaches a low-low setpoint LALL-5201 or high-high setpoint LAHH-5201, an alarm is generated at the SCADA level. In addition, the triggered level switch LALL-5201 shuts off the incubation reuse pumps P-530 and P-531.
- Discharge of the incubation reuse pumps P-530 and P-531 is monitored and recorded by a flow meter FM-202. Any alarm condition from the flow meter transmitter is returned to the SCADA.
- The incubation reuse pump control panels return pump run status, alarms, and faults to the SCADA.
- The incubation reuse pump motor has winding high temperature protection (TSH-5201, TSH-5202) that stops motor operation via controls in the VFD when high temperature occurs.
- The reuse pump motor has a moisture sensor (MSH-5201, MSH-5202) that stops motor operation via controls in the VFD when moisture is detected.
- VFD Level:

- Each VFD has an Operator Interface with the controls and displays PUMP SPEED (SI), VFD FAIL (YA) alarm and shutdown, MOTOR HIGH TEMPERATURE (TSH) alarm and shutdown, MOTOR MOISTURE (MSH) alarm and shutdown.
- Pressing of the reset button (HMS) is necessary to resume operation after a shutdown alarm.
- When the HAND/OFF/AUTO (HS) switch is in the HAND position, the operator manually controls pump operation by using the START/STOP (HS) switch, (and the manual speed control SC) at the VFD Operator Interface.
- When the HAND/OFF/AUTO switch (HS) is in the AUTO position, VFD manual control is disabled.

- AUTO mode (two loops):
  - Loop 1 - Flow Rate: When the mode selector is in "AUTO" the plant PLC will automatically start/stop the incubation reuse pumps P-530 or P-531 and increase/decrease their speed to maintain the operator setpoint INCUBATION REUSE FLOW RATE as measured by the flow meter FM-202. The PLC will start pumps at an adjustable minimum speed (initially set at 40 Hz) and then the pumps shall modulate to keep the flowmeter output with in an adjustable dead band of the setpoint (initially 2.5% dead band). In the event of the flow rate cannot be achieved, the standby pump will started and an alarm will be triggered in the SCADA.
  - Loop 2 – Q-Water Level Maintenance in the Incubation Reuse Wet Well:
    The PLC will maintain Q-water level in the incubation reuse wet well measured by LIT-5203. If the water level inside the incubation reuse wet well as measured by LIT-5203 is below the Q-water level setpoint, the PLC will slow down the reuse pump(s) until the water level rises to the Q-water level setpoint. If the incubation reuse pump(s) reach the minimum speed setpoint for longer than an adjustable time delay setpoint the PLC will stop one incubation reuse pump at a time. The PLC will then automatically adjust speed of the remaining pump(s) to maintain the Q-water level setpoint.
    If the water level inside the incubation reuse wet well as measured by LIT-5203 is above the adjustable Q-water level setpoint, the PLC will speed up running pump(s) until the water level in the incubation reuse wet well achieves the Q-water level setpoint. If the incubation reuse pump(s) reach the maximum speed setpoint for longer than an adjustable time delay setpoint but the Q-water level setpoint is still not achieved, the PLC will start one more reuse pump at a time. The PLC will then automatically adjust speed of the running reuse pumps to maintain the Q-water level setpoint.
    The incubation reuse pumps P-530 and P-531 are automatically started and stopped based on water level in the in the incubation reuse wet well. The reuse pump is started up and shut off on achievement of high-level setpoint LAH-5203 and low-level setpoint LAL-5203 correspondingly.

5.7 Chiller System

A chiller system will be used in the incubation building to supply chilled water to the incubation stacks. The chiller is supplied by well water from the main supply trough in the incubation room. A chilled water supply pipe returns chilled water back to the vertical incubators through a dedicated pipeline. A drain line from the chiller discharges water from the hot side of the internal heat exchangers out of the building.

Control Functions:

- The chiller will be controlled by a temperature sensor downstream of the chiller unit (TE-5404) that provides temperature readings to a controller.
    - The controller provides temperature readings to the PLC for display and logging
    - Temperature set point controls in the PLC are used to generate alarms if the measured temperature is outside of an adjustable range.
- The chiller internal control system cycles compressors to maintain the leaving chilled water supply temperatures.

5.8 Formalin Treatment System

A formalin treatment room is provided in the Incubation Building for storing formalin barrels. A formalin dosing system consisting of a dosing pump and other instruments and is intended to be installed in the future by others and to be connected to the incubation stacks and, if desired, the Kitoi boxes.

The formalin room in the Incubation Building is intended to store a maximum of 2 x 55-gallon drums of the chemical. Additional barrels are intended to be stored in a dedicated chemical storage cabinet located outside the building.

The formalin piping system will have a utility water connection for flushing to be rid of excess formalin. Flushing will be controlled by a solenoid valve (SOV-5501).

5.9 Formalin Metering System

When formalin is dosed for fungal control into the vertical incubation stacks and/or the Kitoi boxes, effluent from the drain trenches is intended to be redirected to the formalin metering tank (T-540) and then pumped back into the drain at a rate meeting label dilution requirement. The intent is for the treated water from one row of incubation stacks, up to 64 total, to be directed to the formalin metering tank at one time. For this purpose, the respective isolation valve on the outlet pipe to the incubation reuse pump station (BFV-521 or BFV-522) should be manually closed for the row that is receiving and the isolation valves (BFV-520 or BFV-523) on the outlet pipe to the formalin metering tank should be manually opened.

The formalin metering tank has a pump P-540 to pump out formalin contaminated water to the clarifier for further dilution and discharge into the pond to meet dilution requirements. There is also a shelf spare pump P-541.

Features of this item include the following:

- Formalin dilution pump P-540 with VFD control
- Shelf spare pump P-541
- Float switch LSHH-5205 for high-high level alarm
- Level indicating transmitter LIT-5205 for control of the formalin dilution pump P-540 and water level in the formalin metering tank
- Flow meter FM-540 and transmitter FQIT-5404
- Pressure gauge PI-5204 and pressure indicating transmitter PIT-5204 on the discharge header of the formalin dilution pump P-540/541

Control Functions:

- Operation of the formalin dilution pump P-540 is controlled by a dedicated Variable Frequency Drive VFD- P-520 in response to local manual controls, or remote SCADA commands.

- The pump speed is adjusted by the formalin dilution pump VFD to maintain an adjustable FORMALIN WATER FLOW SETPOINT measured by the flow meter FM-540. The VFD speed shall also be manually adjustable by the SCADA.
- Discharge of the formalin dilution pump P-520 is monitored and recorded by flow meter FM-540. Any alarm condition from the flow meter transmitter is returned to the SCADA.
- Discharge pressure of the formalin dilution pump P-540 is monitored by pressure gauge PI-5204 and pressure indicating transmitter PIT-5204. Once a high-pressure setpoint PAH-5204 or the low-pressure setpoint PAL-5204 is triggered, an alarm is generated at the SCADA level. Once a high-high-pressure setpoint PAHH-5204 is triggered, the formalin dilution pump P-540 is shut down and an alarm is generated at the SCADA level.

- Float switch LSHH-5205 and level indicating transmitter LIT-5205 track four water elevations: LOW-LOW (LALL-5204), LOW (LAL-5204), HIGH (LAH-5204), and HIGH-HIGH (LAHH -5204).
- The normal water level operating range in the formalin metering tank is between the LOW (LAL-5205) and the HIGH (LAH-5205) level setpoints. These water level setpoints shut down and start up the formalin dilution pump P-520 correspondingly.
- The triggering LOW-LOW setpoint shuts down the formalin dilution pump P-520 and generates an alarm at the SCADA level.
- The triggering HIGH-HIGH setpoint generates an alarm at the SCADA level.
- The pump control panel returns pump run status, alarms, and faults to the SCADA.
- The pump motor has winding high temperature protection that stops motor operation via controls in the VFD when high temperature occurs.
- The pump motor has a moisture sensor that stops motor operation via controls in the VFD when moisture is detected.
- VFD Level:
    - Each VFD has an Operator Interface with the controls and displays PUMP SPEED (SI), VFD FAIL (YA) alarm and shutdown, MOTOR HIGH TEMPERATURE (TSH) alarm and shutdown, MOTOR MOISTURE (MSH) alarm and shutdown.
    - Pressing of the reset button (HMS) is necessary to resume operation after a shutdown alarm.
    - When the HAND/OFF/AUTO (HS) switch is in the HAND position, the operator manually controls pump operation by using the START/STOP (HS) switch, (and the manual speed control SC) at the VFD Operator Interface.
    - When the HAND/OFF/AUTO switch (HS) is in the AUTO position, VFD manual control is disabled.
- AUTO mode (one loop):
    - Loop 1 - Flow Rate: When the mode selector is in "AUTO" the plant PLC will automatically start/stop the formalin dilution pump P-540 when the water level in the formalin metering tank is above the LOW (LAL-5205) set point and increase/decrease the pump speed to maintain the operator setpoint FORMALIN WATER FLOW SETPOINT as measured by the flow meter FM-540. The PLC will start pump at an adjustable minimum speed (initially set at 40 Hz) and then the pump shall modulate to keep the flowmeter output with in an adjustable dead band of the setpoint (initially 2.5% dead band). The normal water level operating range in the formalin metering tank is between the LOW (LAL-5205) and the HIGH (LAH-5205) level setpoints. These water level setpoints shut down and start up the formalin dilution pump P-540 correspondingly.

6 Circular Rearing Tanks

Circular rearing tanks are provided for the Chum grow-out phase. There are a total of 10 circular tanks, each 26-feet diameter with an operating water depth of 4.5 feet. Water supply for the tanks is primarily surface water provided from the headbox. A 6-inch pipe mounted over the top of the side wall supplies a manifold inside the tank with a series of tapped holes or nozzles. The holes are intended to be oriented tangentially to the tank wall to create a circular flow pattern that draws deposited sediment and other materials to the center drain by centripetal force.

The tanks are Cornell-style dual-drain tanks with both a bottom outlet and a side outlet. When the circular rearing tank is in service, the effluent flow splits between the two outlets: around 20% goes to the bottom outlet and directed to the clarifier for solids removal, and 80% goes to the side box outlet and then redirected to Battle Creek Pond. The flow split is controlled by adjusting heights of standpipes located on both the bottom outlet and the side outlet. There are two standpipes on the side outlet that allow this effluent to be directed either to Battle Creek Pond or for release below the dam of Battle Creek Pond. The bottom outlet of each circular rearing tank is also connected with a pipe (separate from the drain) for fish release to the Battle Creek Pond. The fish release is controlled by a manually controlled knife gate located outside the tank. When opened, flows allow fish to be released to the pond.

Features of each circular rearing tank include the following:

- An individual flow indicating transmitter FM-601 to FM-610 mounted vertically on the inlet pipe.
- Individual isolation butterfly valve BFV-601 to BFV-610 on the inlet pipe.
- Individual isolation knife gate KGV-601 to KGV-610 on the bottom outlet for fish release.

Control Functions:

- The flow indicating transmitters FM-601 to FM-610 monitor the inlet flow rate to each circular rearing tank. Any alarm condition from the flow meters are returned to the SCADA.
- The flow meter signals for groups of 8 tanks shall be displayed on a local HMI screen nearby the respective circular rearing tank group. Flows shall also be displayed and recorded by the plant SCADA.
- In the SCADA, an adjustable TANK FLOW SET POINT shall be available for each of the circular rearing tanks. An alarm shall be triggered in the event of an inlet flow change outside of an adjustable range (initially 5%) around the flow setpoint.
- In order to isolate the circular rearing tank, the correspondent individual isolation butterfly valve (manually operated) BFV-601 to BFV-610 on the inlet pipe should be closed.
- In order to release fish into the Battle Creek Pond, the bottom screen in the tank should be hinged open and the correspondent individual knife gate KGV-601 to KGV-610 (manually operated) on the fish release pipe should also be opened.

7 Wastewater Clarifier

The clarifier CFR-701 is a circular concrete basin with a conical floor equipped with a rake mechanism that constantly rotates to promote deposition of solids. Clarified effluent spills over a perimeter weir into launder and is routed to Battle Creek below the dam. Settled material is drawn off the bottom of the tank into a wet

sludge wet well where a pipe with a camlock connection comes up above grade for a vac truck to remove solids.

Control Functions:

- The clarifier rake has a local control station that is provided with an ON/OFF switch. When placed in the ON mode the rake will RUN. There is no SCADA function.
- Clarifier rake rotating arm torque is monitored to provide a HIGH TORQUE alarm and HIGH-HIGH TORQUE shutdown alarm.
- An isolation plug valve (PV-701) controls the blowdown from the clarifier basin. The valve shall opened when sediment from the basin is ready to be removed.

8 Process Monitoring and Control

8.1 Flow Meters

Flow meters will be provided at the multiple locations to allow monitoring and management of water flows throughout the hatchery. The flow meters will be magnetic flow meters for full-flow pipes or area-velocity meters for partially full pipes on drain systems.

Control Functions:

- Flow signal shall be provided to main plant PLC for display, logging, and monitoring; and
- Remote transmitters for each flow meter will allow for local refinement of flow rates and distribution while operators are adjusting system operations.

8.2 Dissolved Oxygen Sensing

Dissolved Oxygen (DO) sensors are provided in two locations:

- Headbox Surface Water Distribution Chamber
- Well water storage tank

DO sensors provide both dissolved oxygen and temperature readings for display, logging, and monitoring.

Control Functions:

- DO sensors provide dissolved oxygen and temperature readings to a controller. The controller provides oxygen and temperature readings to the plant PLC for display and logging.
- The plant PLC shall allow a Dissolved Oxygen Set Point to be established. When the DO concentration from one of the sensors drops below the set point, a time delay relay is triggered.
- If the dissolved oxygen level does not recover within a time delay set point, a Low Oxygen alarm shall be triggered.

8.3 Temperature Sensing

Temperature monitoring is provided for the chilled water system in the incubation building. There is one temperature sensor on the Chilled Water Supply between the chiller system and the vertical incubators.

Control Functions:

- The temperature transmitter provides temperature readings to the plant PLC for display and logging.
- Temperature set point controls in existing plant PLC are used to generate alarms if the measured temperature is outside of an adjustable range.
- Temperature sensor: TIT-5404
- Temperature Guage: TI5404

9 Miscellaneous Systems

9.1 Non-Potable Utility Water

Utility water is consumed by the chiller system and by the formalin treatment system.

The branch supplying utility water for the chiller system is equipped with manual ball valve and is not controlled by the PLC.

The branch supplying utility water for the formalin system is equipped with pressure indicator PI-5501, manual ball valves 5-V-64 and 5-V-66 for pressure adjustment, and solenoid valve SOV-5501 triggered by the signal from the formalin treatment system.

Geotechnical Engineering Report – FINAL

Battle Creek Hatchery

April 09, 2021

Prepared for:

Tulalip Tribes

Prepared by:

Stantec Consulting Services Inc.

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1.0 INTRODUCTION

1.1 PURPOSE OF WORK

The purpose of this report is to document the results of a geotechnical field investigation and subsequent laboratory testing conducted at the proposed Battle Creek Hatchery site, to summarize the subsurface conditions, to evaluate the engineering properties of the soils, and to provide geotechnical recommendations for design and construction of the project. Revisions to the recommendations in this report may be required if the design changes from the features described herein.

1.2 PROJECT DESCRIPTION

The Tulalip Tribes of Washington is implementing a new chum hatchery located adjacent to Battle Creek on the Tulalip Reservation in Snohomish County, Washington. The existing site comprises approximately 3.5 acres off of Totem Beach Rd and includes a diversion dam and spawning shed that are utilized as part of existing rearing programs. The hatchery will include new structures and underground piping described below and shown in **Figure 1**. The elevations of proposed structures and ground surface is shown in **Table 1**.

Pumped Intake: A pumped intake structure will be constructed along the north bank of the Battle Creek impoundment upstream of the existing diversion dam. This structure will consist of an in-river concrete sump structure and above-grade pump station to pump river water for use at the hatchery. The structure will include a debris trash rack, fish exclusion screens, and connecting piping. The foundation will be a 25-ft by 29-ft by 2-ft thick mat foundation located at the toe of the riverbank in the impounded creek.

Well Water Storage Tank: For groundwater storage, a well water storage tank will be constructed adjacent to the recently drilled well near Wesley Charles Lane at the north end of the site. The storage tank will be an at-grade concrete structure with dimensions of 16-ft x 16-ft in plan and 15 feet tall. This structure will be founded on an 18-ft by 18-ft concrete mat with its top at the ground surface.

Head Box: A head box will be constructed to the northeast of a proposed incubation building (described next). The head box will be an above-grade structure consisting of a concrete storage tank and surrounding metal platform. The concrete tank will have dimensions of approximately 10-ft by 19-ft in plan with the top deck approximately 11-ft above surrounding grade. A metal platform will surround the concrete tank and support two degassing columns and a stairway up to the top deck. The total footprint, including the metal platform is approximately 23-ft by 26-ft in plan. The concrete structure will also support two low head oxygenation (LHO) units within the structure as well as slide gate controls for water distribution. The concrete portion will be supported on a 12-ft by 21-ft mat foundation buried

approximately 5-ft below grade. The metal platform, stairway, and degassing columns will be supported by columns on either isolated pads or spread footings located at the ground surface.

Incubation Building: An incubation building will be constructed in the northern half of the project site near the intersection of 28th Ave NW and the existing gravel access road that leads down to the diversion dam. The incubation building will be a 5,000 square feet, at-grade, single story pre-engineered metal building consisting of incubation facilities including a large incubation room, egg processing room, mechanical treatment room; crew facilities including bathrooms, a break room, and boot room; and additional rooms for formalin storage, feed storage room, and electrical equipment. The building will be supported on continuous strip footings at the building perimeter. The building's floor slab will be interrupted by concrete sump structures in the incubation room that will extend to approximately 3 feet below the ground surface. The building perimeter also includes overhanging roofs that will be supported by columns founded on isolated pads.

Located in the parking area to the northwest of the incubation building will be a small pump station for incubation water reuse. The pump station will consist of a circular pre-cast concrete wet well with a base located approximately 10-feet below the ground surface. This structure will have submersible reuse pumps, valves, and associated piping. Also located in this parking area will be a buried 12,000-gallon fiberglass tank for storage of formalin discharge water. This fiberglass storage tank will be anchored using a series of concrete deadman anchors and straps designed by the manufacturer.

Rearing Tanks: 32 circular rearing tanks will be constructed in the southern half of the site to the southeast of the incubation building. These tanks will be 16 to16.5-ft diameter fiberglass rearing tanks and associated supply piping, drain piping, and fish release piping. Each of these circular tanks will be 4-feet tall and constructed on a sand or flowable grout fill foundation.

Reuse Treatment Structure: A reuse treatment structure consisting of concrete sump structure and pre-engineered metal building will be located at the east end of the site between the circular rearing tanks and Battle Creek. Its base slab will be approximately 5-feet below surrounding grade and will support micro screen drum filters and metal access platforms inside the sump. The sump walls will extend up above grade and support a pre-engineered metal building. In plan, the structure and building will be approximately 23-ft by 25-feet.

Wastewater Clarifier: A wastewater clarifier will be constructed between the rearing tanks and the outfall to Battle Creek below the diversion dam. The clarifier will be a circular concrete structure consisting of a concrete sump, membrane base slab, and walls. The structure will be approximately 22-ft in diameter (20-ft inside) and 12-ft high. A fabricated center distribution column, raking arm, and access platform spanning between the structure walls will be installed inside the structure.

Site Improvements: Project improvements also consist of asphalt paving along the existing gravel access road to the diversion dam, new asphalt access roadings and parking areas around the incubation building, circular rearing tanks, and to the reuse treatment structure. Gravel surfacing is also proposed in areas where vehicular traffic is not frequent or anticipated.

Table 1: Proposed Structure Subgrade and Existing Ground Surface Elevations

Structure	Proposed Foundation Subgrade Elevation (ft)	Existing Ground Surface Elevation (ft)
Pumped Intake Structure	15	30 to 24
Well Water Storage Tank	57	59
Head Box Structure	42	49
Incubation Building	45	52 to 46
Circular Rearing Tanks	43 (bottom of fiberglass tank)	42 to 50
Reuse Treatment Structure	40	46
Wastewater Clarifier	25	24 to 32

Elevations presented in this report are based on NAVD 88 geodetic vertical datum. Coordinates of boreholes performed and recorded on logs are based on WGS 84 Web Mercator coordinate system.

1.3 SCOPE OF INVESTIGATION

Stantec Consulting Services Inc. (Stantec) has been retained by the Tulalip Tribes of Washington to prepare this report. Stantec's scope of work (SOW) for the geotechnical investigation and report described in Subtask 2.2 of our Professional Services Agreement dated April 1, 2019, which included literature review, development of a geotechnical investigation plan, field investigation, well installation, laboratory testing, and development of geotechnical recommendations and opinions.

No monitoring wells were installed during the field investigation for this project. Wells were not installed due to a consistent contact elevation with groundwater during boring operations. Groundwater was encountered in boreholes at a similar elevation as the nearby water in Battle Creek.

2.0 GEOLOGIC CONDITIONS

2.1 REGIONAL AND SITE GEOLOGY

Regional Geology

The Battle Creek Hatchery site is in the Puget Lowland of the Pacific Border physiographic province (WA DNR, 2020). The Puget Lowland is located between the Olympic Mountains to the west and the Cascade Range to the east. Faults identified as Quaternary-active have been mapped within 20 miles of the project site based on the USGS Fault and Fold database (USGS, 2004).

The geologic history of the Puget Sound Lowlands in Washington developed from crustal deformation from the Cascadia Subduction Zone, sedimentary erosion, and sedimentary deposition (Booth, 2003). The Olympic Mountains formed in the Miocene era (Booth, 2003) Repeated glaciations occurred in the region during the Pleistocene era (Booth, 2003). The repeated glaciations ended with the Fraser Glaciation, a Vashon Age glacier (Booth, 2003). Following the glaciations (through the Pleistocene), fluvial processes continued to sculpt the landscape (Booth, 2003).

Site Geology

The Battle Creek Hatchery site is located within the Tulalip Reservation approximately 4 miles west of Marysville, Washington. The site is approximately 1,000 feet east of Tulalip Bay, a body of water off Possession Sound, which is part of Puget Sound. The site is north and northeast of Battle Creek. Battle Creek is a creek that runs into Tulalip Bay.

Pleistocene recessional glacial outwash deposits overlie the Pleistocene advanced outwash at the project location. The recessional outwash is characterized by stratified sand and gravel deposits with silt and clay layers present locally near the project site (USGS, 1985). Rock particles within these strata are varied mineralogically (USGS, 1985). Much of the material above the water table is oxidized and may include materials cemented by iron oxide (USGS, 1985). Material below the water table is typically non-oxidized and medium gray (USGS, 1985).

2.2 REGIONAL SEISMICITY

The site is located in a seismically active region. There are mainly three sources for earthquakes that can affect the region containing the site. “Interface” earthquakes which occur between the subducting oceanic plates and the North American plate, “intraplate” earthquakes which occur within subducting oceanic plates, and “crustal” earthquakes within the North American Plate. “Interface” earthquakes in the region occur on the Cascadia Subduction Zone. “Crustal” earthquakes occur on faults which have been mapped as active or potentially active; or occur on faults which are unknown and have not yet been mapped.



Mapped fault locations and descriptions for nearby faults can be found on the USGS Quaternary Fault and Fold Database (USGS, 2014). The nearest faults to the site are the Southern Whidbey Island Fault Zone which is approximately 7.2 miles from the site and the Utsalady Point Fault which is approximately 16.1 miles from the site (USGS, 2014). There are no other nearby faults within 10 miles of the site (USGS, 2014).

2.3 GEOLOGIC HAZARDS

Stantec has assessed the following geologic hazards at the site: surface rupture, soil liquefaction, lateral spreading, slope instability, swelling or collapsible soils, volcanic lava or lahar flow, tsunami, and flooding.

Surface Rupture: Based on review of published geologic literature and maps, and the subsurface investigations, there is no evidence that active or potentially-active faults cross the Battle Creek Hatchery site. The nearest fault to the site is the Southern Whidbey Island Fault Zone which is approximately 7.2 miles from the site. Therefore, the potential for surface rupture across the project site is highly unlikely.

Soil Liquefaction: Liquefaction is a soil behavior phenomenon in which soil undergoes a rapid loss in effective strength due to the development of high excess pore water pressure generated by earthquake ground shaking. Soils that are most susceptible to liquefaction are clean, loose, uniformly graded, saturated sands or saturated soft to firm low plasticity silts that lie near to the ground surface, a depth usually considered to be less than 60 feet. Additionally, soils most susceptible to liquefaction are sediments that were deposited during the Holocene Epoch (i.e. less than 11,000 years ago) and do not exhibit any degree of cementation associated with older aged deposits. Subsurface conditions at this site consist mainly of mostly 7 to 12 feet of stiff to hard, medium plasticity clays overlying dense to very dense silty sands, and very dense silty gravels to the deepest drilled depth of 31.5 feet bgs. Groundwater levels are generally 20 to 25 feet bgs. The deposits below groundwater were very dense (often exhibited practical refusal while performing SPTS) and were deposited during the Pleistocene Epoch. The water well drill log advanced near the proposed wet well tank indicates that these recessional glacial outwash deposits extend deeper than 60 feet bgs in the area, which is consistent with mapped descriptions of the general thicknesses of this deposit. Based on these subsurface conditions and our experience with liquefaction triggering potential analyses using high cyclic stress ratios associated with the seismicity of this area, it is judged that soil liquefaction at the site is a very low risk. Accordingly, the risk is also very low for hazards associated with liquefaction including; post-liquefaction reconsolidation settlement, lateral spreading of free-face slopes towards Battle Creek, and loss of bearing capacity of supporting soils beneath the proposed structures.

Slope Instability: Much of the proposed project site is located at the top of an incised channel bank adjacent to Battle Creek. To the SE of the proposed rearing tanks, the hillside is relatively steep with slopes reaching 2H:1V towards Battle Creek. The pumped intake structure is proposed to be built at the

base of this slope. This slope extends from the existing gravel lot in the south of the property and extends to the existing dam structure.

To the SW of the rearing tanks, the hillside is also steep dipping to the SW towards a lower reach of Battle Creek at slopes of up to 2.7H:1V. The wastewater clarifier is proposed to be built on this hillside and consideration should be taken by the design team of its induced surcharge load onto the slope with respect to slope stability (in addition to the potential for differential settlement of the tank constructed along this slope, discussed in Section 5).

The slopes down to Battle Creek are shown on **Figure 1**. No signs of global or shallow slope instability were observed during cursory observations of these slopes. No slope stability analyses of the slopes leading to Battle Creek were performed as part of this scope.

Swelling/Collapsible Soils: Swelling soils and collapsible soils are soils that are subject change in volume based on the introduction of moisture from their current moisture state. Swelling soils are also known as expansive soils. These soils increase in volume when they absorb water. Soils containing clay are the most common soils to exhibit swelling characteristics. Soils on this project site are not anticipated to experience swelling or collapse upon wetting. The clay soils of the upper layer were observed to experience negligible swelling under laboratory conditions.

Volcano: This site is not located in the drainage of any active volcanoes. As such, there is no risk of volcanic lava or lahar flow hazard for the site.

Tsunami: Tsunami waves are giant waves caused by a large displacement of water. These waves can be created from earthquakes, volcanic eruptions, or large landslides. The project site is located near Tulalip Bay which is connected to larger bodies of water, including Puget Sound. Due to the proximity of the project site to these bodies of water, there is tsunami risk to the site. Washington State Geologists and the Tulalip Tribe anticipate a maximum tsunami wave height of 30-ft (Tulalip, 2010). A rate of occurrence for these waves has not been calculated (Tulalip, 2010). No written records of tsunamis exist in the Puget Sound but verbal accounts exist of a landslide induced wave that occurred sometime in the 1820s or 1830s (Tulalip, 2010). Based on published tsunami hazard mapping, the project site is susceptible to tsunami inundation from a 30-ft wave (Tulalip, 2010).

Flood: The project site is not located in a Federal Emergency Management published 100-year floodplain (FEMA, 2020). As such, there is low flood hazard for the site.

3.0 SUBSURFACE INVESTIGATION AND LABORATORY TESTING

The field investigation program was conducted in the project area (**Figure 1**) and included six soil boreholes. The six boreholes were conducted to evaluate the subsurface conditions throughout the project site and at key locations for proposed structures. Representative split-spoon SPT soil samples from each hole and one representative Shelby tube soil sample were selected for soil laboratory tests. No piezometers were installed.

The field investigation and laboratory testing program are described in the sub-sections below.

3.1 GEOTECHNICAL BOREHOLES

A total of six soil boreholes (B-2 through B-7) were drilled by Gregory Drilling, Inc. on September 17 and September 18, 2020 to the depths summarized on **Table 2.** A seventh borehole (B-1) was originally planned but was ultimately not advanced due to site logistical issues. Borehole locations are shown on **Figure 1**.

Table 2. Geotechnical Borehole Depths

Borehole	Depth (feet)
B-2	21.5
B-3	26.5
B-4	31.5
B-5	16.5
B-6	21.5
B-7	26.5

Boreholes B-2 to B-7 were drilled using hollow stem auger methods on a track-mounted CME 55 rig with a bit size of 4-7/8". The drill rig was equipped with an automatic trip hammer to perform SPTs. A Stantec representative was on-site throughout the drilling and sampling operations. The representative directed the drill crew, logged the subsurface materials encountered and collected the soil samples. The boreholes were logged in the field in general conformance with the American Society for Testing and Materials (ASTM) D 2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure*. The soil's color, texture, moisture content, and consistency/relative density were logged. The boreholes did not reach bedrock. The borehole logs are included in **Appendix A** and photographs of the

soils recovered with the spilt-spoon sampler are included in **Appendix B**. The recovered soil samples were transported to storage, and selected samples were delivered to Benchmark Geolabs for soil laboratory testing.

Standard Penetration Test (SPT) blow count measurements were taken at 5-foot intervals. SPT resistance values were recorded by counting the number of blows required to drive the split-spoon sampler a total of 18-inches in 6-inch intervals with a 140-lb hammer dropped from a height above the anvil of 30-inches. The sum of the number of blows to drive the sampler the final two 6-inch increments was recorded in the borehole logs as the SPT blow count. If more than 50 blows were required for a 6-inch interval, the sampler was determined to have met refusal and the number of inches driven and the number of blows was recorded. SPT samples were retained in plastic bags for laboratory testing. Three Shelby tube samples were taken in accordance with ASTM D1587 to collect soil samples for consolidation and strength laboratory testing. Piezometers were not installed in any of the boreholes. All the boreholes were backfilled with 3/8-inch dehydrated bentonite chips in accordance with the Washington Department of Ecology abandonment requirements as indicated by Gregory Drilling, Inc.

3.2 LABORATORY TESTING

The following laboratory tests were performed in general accordance with ASTM procedures:

- In-Situ Moisture and Dry Density (ASTM D2216 and ASTM D7263b): The in-situ moisture and density are calculated by weighing and measuring the recovered drive samples (Modified California barrel) or pushed samples (Shelby tube) obtained from the boreholes.
- Specific Gravity (ASTM D854): This test measures the ratio of density of soil solids to the density of water.
- Sieve Analysis (ASTM D1140 and ASTM D422): This test is used to evaluate the distribution of soil grain sizes, which constitute the soil fabric and is used in soil classification and assessment of soil engineering behavior.
- Atterberg Limits (ASTM D 4318): The Atterberg Limits are utilized to classify fine-grained soils and correlate them to specific engineering properties. Atterberg Limits describe the consistency and plasticity of fine-grained soils with varying degrees of moisture. Atterberg Limits tests are used to determine the water content at which soil behavior becomes liquid or brittle. The liquid limit (LL) represents the moisture content at which the soil begins to flow like a liquid, and the plastic limit (PL) represents the moisture content when it ceases to be plastic and becomes brittle. Subtracting the plastic limit from the liquid limit yields the plasticity index (PI). The plasticity index defines the typical range of water content for a soil and is related to the maximum volume change (or compressibility) of the soil.

- One Dimensional Consolidation of Soil (ASTM D2435A): Selected Shelby tube samples are subjected to one-dimensional consolidation testing. The samples are tested in accordance with ASTM D2435A. The one-dimensional consolidation of the soil is used to estimate the long-term primary consolidation settlement from proposed structural loads.
- pH of Soils (ASTM G51): This test is used to measure the pH of the soils and evaluate corrosivity for buried steel pipes.
- Electrical Resistivity Testing (ASTM G-57): The resistivity testing is used to measure the resistivity of the soils for the constructed pipelines. The resistivity testing was performed at saturated moisture content.
- Chloride and Sulfate Content (EPA 300.0): This test is used to measure the chloride and sulfate content in soils for evaluation of corrosivity of buried steel and concrete, respectively.
- Sulfide Content (Acetate Paper): The sulfide content in soil is measured using Lead Acetate Paper. This test is also used to evaluate corrosivity.

The soil laboratory test results are presented in **Appendix C.**

4.0 SITE CHARACTERIZATION AND SUBSURFACE CONDITIONS

4.1 SURFACE CONDITIONS

The project site is currently developed as shown along with proposed features in **Figure 1**. The property currently consists of a gravel access road, forested land, bushy undergrowth, wetland vegetation, an existing dam structure, and the adjacent creek.

The existing roadway includes 28th Ave NW and a gravel driveway. 28th Ave NW is a gravel/dirt road that connects between Totem Beach Road and Ernie Cladoosby Sr. Street. To the SE of 28th Ave NW is a gravel access road that extends downhill to the existing dam structure. Access to the diversion dam area is restricted by a fence and lockable metal gate. The road includes improved surface leading to both the top and bottom of the existing dam structure and includes a truck turnaround/ parking area that is relatively flat. The access road begins at 28th Ave NW at approximately El. 48 feet and ends near the toe of the existing dam structure at approximately El. 18 feet.

To the northeast of the access road the site is heavily forested. The terrain varies in elevation across the site from approximately 59 ft to 40 feet ft. The forest is mature (~1 to 3-foot diameter trees in places) with bushy undergrowth and an organic topsoil layer. The site was cleared of blackberries and other undergrowth ahead of the drilling operations. Paths were recently cleared of trees and undergrowth made wide enough for a track drill rig to access the boreholes for this project. During the initial field investigation for this study, the ground surface in the forested section of the project site was saturated at its surface with surface ponding due to recent precipitation. This surficial saturation and ponding caused the ground surface in the forested lot to be impassable with a track-mounted rig until a several-month period of dry weather allowed it to dry. No natural springs or surface ponding due to groundwater was observed near the proposed structures and utilities outside of the existing Battle Creek.

Battle Creek generally runs from the NE to the SW, winding around the project site to the east, southeast, south, and southwest of the proposed structures and eventually discharging into Tulalip Bay to the southwest. Battle Creek runs from approximately El. 24 to El. 22 feet with stop logs in place on the diversion dam; when stop logs are removed the impounded area of the creek is lowered to the crest of the diversion structure (El. 11.3). The creek banks are relatively steep slopes that extend up to the project site.

4.2 SUBSURFACE CONDITIONS

Subsurface conditions in the vicinity of the proposed groundwater storage tank, head box, incubation building, parking area, rearing tanks, reuse treatment structure, and wastewater clarifier are characterized

below. Conditions at the proposed water intake structure were not directly investigated as part of this study; at that location we estimate that younger sediment has accumulated within the Battle Creek Channel having thicknesses likely on the order of 5 to 10 feet that are present above very dense granular soils as were encountered in the lower portions of the drill holes performed at the site. The explored depths of the boreholes (B-2 to B-7) encountered various soil deposits within the glacial outwash deposits that appear to be horizontally continuous between the boreholes. Depths of the various soil strata are characterized in general ranges of depth, for more-detailed depth and elevation information of strata, borehole logs in **Appendix A** should be referenced. Material descriptions in the bore logs are based on the Unified Soil Classification System (USCS).

- 0 to 1 feet (bgs): Organic-rich clayey topsoil with roots;
- 1 to 7-12 feet (bgs): Lean clay (CL), stiff to hard, low to medium plasticity, moist, medium brown to medium gray;
- 7-10 to 23-32 feet (bgs): Silty gravel with sand (GM), silty sand with gravel (SM), and silt with sand (ML), very dense and hard, non-plastic, dry to wet, medium brown to medium gray;

4.3 GROUNDWATER

Groundwater was encountered during drilling in geotechnical boreholes B-2, B-3, B-4, and B-6. During drilling operations, groundwater was generally encountered 20-25 feet bgs or between El. 22 and 25 feet. **Table 3** below summarizes the depths and elevations that groundwater was encountered. At the time of drilling, the water surface of Battle Creek was roughly El. 22 feet. No piezometers were installed in boreholes due to the apparently consistent elevation at which groundwater was encountered during drilling and the appearance that groundwater depths encountered during drilling were representative of static groundwater levels.

Table 3: Depth and Elevation of Groundwater

Feature	Depth to Groundwater (ft.)	Elevation of Groundwater or Water Surface (ft.)
Battle Creek	--	22
B-2	20	22
B-3	20	23
B-4	25	22
B-6	20	25

4.4 LABORATORY TESTING

Selected soil samples were subjected to laboratory testing. All results of laboratory testing are presented in **Appendix B**. A summary of the soil laboratory test results is shown in **Table 4**.

Table 4. Laboratory Testing Results on Soil Samples

Location Information				USCS		ASTM D2216 Natural Moisture Content	ASTM D4318 Liquid Limit, Plastic Limit, Plasticity Index			ASTM D854 Specific Gravity	ASTM D1140 or ASTM D422 Particle Size Gradation Analysis			ASTM D2435 Consolidation Test	Corrosivity Report
Borehole ID	Sample Type	Depth (ft bgs) From	Depth (ft bgs) To	Symbol	Soil Type	Percent (%)	Liquid Limit	Plastic Limit	Plasticity Index		% Gravel	%Sand	%Silt and Clay	Stress-Strain Curve	
B-2	SS	5.0	6.5	CL	Lean Clay	25.1	41	24	17		0.1	4.6	95.3		
B-2	SS	10.0	11.5	SM	Silty Sand with Gravel	6.7	16	14	2		32.0	38.0	30.0		
B-2	SS	20.0	21.5	SM	Silty Sand with Gravel	10.9	NP	NP	NP		16.9	45.3	37.8		
B-3	ST	5.0	6.5	CL	Lean Clay					2.748	0.1	4.0	95.9	See Appendix B	
B-3	SS	10.0	11.5	SM	Silty Sand with Gravel	8.4					24.7	43.4	31.9		
B-4	SS	15.0	16.5	GM	Silty Gravel with Sand	6.5					35.6	32.7	31.7		
B-5	SS	5.0	6.5	CL	Lean Clay	23.5	37	21	16		0.0	12.9	87.1		
B-6	SS	5.0	6.5	CL	Lean Clay	28.9	42	26	16		0.3	4.1	95.6		
B-6	ST	10.0	11.5	CL	Lean Clay					2.763	0.0	5.1	94.9		
B-6	SS	15.0	16.5	SM	Silty Sand with Gravel	9.1					12.0	26.0	62.0		
B-6	SS	25.0	26.5	SM	Silty Sand		NP	NP	NP		6.0	52.0	43.0		
B-7	SS	5.0	6.5	CL	Lean Clay	26.6					0.4	4.6	95.3		See Appendix B
B-7	ST	10.0	11.5	CL	Lean Clay with Sand		45	25	20	2.779	0.8	25.5	73.6		
B-7	SS	15.0	16.5	ML	Sandy Silt						10.4	40.9	48.7		See Appendix B

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5.0 GEOTECHNICAL ENGINEERING ANALYSIS AND RESULTS

5.1 STRUCTURAL LOADS AND ASSUMPTIONS

Geotechnical analyses presented in this report assume that all structures, excluding the wastewater clarifier, will be constructed bearing on subgrade foundations at least 2-ft below the final ground surface. This assumption meets the Snohomish County requirement for building construction using a frost line of 18 inches bgs. The wastewater clarifier will apparently be constructed on a foundation at least 1-ft below the final ground surface.

A well water storage tank will be constructed on a single 18-ft x 18-ft mat foundation with a thickness of 2 feet. A sustained contact pressure of 1,000 psf is assumed to be exerted on the base slab from the combined weight of the water in a full storage tank, tank, and hardware. Boring B-5 provides the nearest available geotechnical information for this structure.

The pumped intake structure will be constructed on a single 25-ft x 29-ft mat foundation. The anticipated load from the structure is understood to be less than the weight of soil excavated for construction for this structure. The structure is currently planned to be approximately 44-ft away from the existing dam structure, located as shown on **Figure 1,** but may be moved farther north along Battle Creek away from the existing dam structure. The subgrade for this structure is planned to be 7.0-ft below the normal operating water surface upstream of the diversion dam. Boring B-2 provides the closest geotechnical information for this structure, however this boring may not accurately reflect the subsurface conditions in the vicinity of the structure, as the ground surface topography is lower in elevation and there is likely on the order of 5 to 10 feet of younger sediment in the creek channel.

The head box structure will be constructed on a combination of isolated spread footings and a buried mat foundation. The metal platform, stairway, and degassing columns will be supported on spread footings having a minimum width of 24 inches. The concrete portions of the structure will be supported by a 12-ft by 21-ft mat foundation bearing on a subgrade about 5 feet below grade. Borehole B-7 provides the closest geotechnical information for this structure.

32-circular rearing tanks will be constructed each having a 16 to 16.5-ft radius. These tanks will be interconnected with a series of supply pipes, drainpipes, and fish release pipes. Each tank is assumed to exert approximately 400 psf of pressure on the ground surface. Boring B-2, B-3, B-4, and B-6 all provide geotechnical information near the corners of the rearing tank grid construction. Fill will need to be placed at the southern portion of the tank grid to raise the existing ground surface to proposed subgrades of the tanks.

A 1 story incubation building will be constructed with foundations consisting of both strip footings and isolated pads. It is understood that 2-ft deep by minimum 24-inch wide strip footings will support the outer walls of the structure. These strip footings will be either 56 or 100-ft in length. Outer roof support columns will be supported on isolated pads having a minimum width of 30-inches. The inside floor of the building will be a slab on grade. The floor slab will be interrupted by concrete sump structures that extend roughly 3-ft below the ground surface. It is understood that the incubation trays and corresponding components will weigh less than the loads from the soil excavation. Borehole B-7 provides the closest geotechnical information for this structure.

A reuse pump station will be installed adjacent to the incubation building. This structure will include a precast manhole wet well built to 10-ft bgs. It is understood that the weight of the structure and corresponding mechanical pumps will weigh less than the excavated soil. Borehole B-7 provides the closest geotechnical information for this structure.

A reuse treatment building will be constructed with a mat foundation 6 feet below the ground surface. It is understood that the weight of the structure and corresponding mechanical pumps will wight less than the excavated soil. Borehole B-3 provides the closest geotechnical information for this structure.

A wastewater clarifier will be constructed on a 1-ft thick by 22-ft diameter mat foundation. It is understood that a fully loaded clarifier will exert a 1,200 psf pressure on the ground surface. This pressure is due to a tank full of water, tank sidings, and associated mechanical components. This structure is set to be located along an existing slope.

5.2 FOUNDATION BEARING CAPACITY

Considering the subsurface conditions encountered in the boreholes and the nature and location of the proposed construction, the following bearing capacity recommendations are provided. The allowable bearing capacities were developed by traditional generalized shear bearing capacity theory. For the mat foundations below, the actual bearing capacity is higher than the allowable capacities listed; the allowable bearing capacities are limited herein by the estimated settlement that could occur with higher stresses. We believe the capacities provided should be sufficient to support the structures based on the assumptions listed in Section 5.1. If higher capacities are required, settlement estimates could be revised upon request.

The strip footings and isolated pads for the headbox and incubation building should be designed using an allowable bearing capacity of 2,000 psf, which is a factored value of the ultimate bearing capacity of the underlying, in-situ clayey soils. The assumed minimum widths of 24 and 30 inches for the strip footings and pads are recommended for this allowable bearing capacity. It is noted that higher bearing capacities could be developed by excavating down to the top of the deeper granular soils (7 to 10 feet of over

excavation) and backfilling with structural fill. If these higher bearing capacities are needed to support this apparently lightly-loaded structure, we should be consulted to provide design recommendations

All other foundations proposed to be constructed for this project are proposed to be mat foundations. These structures include the well water storage tank, embedded foundations for the headbox and reuse water treatment structure, and the wastewater clarifier tank. Allowable bearing capacities for these structures are shown below in **Table 5**.

Table 5: Allowable Bearing Capacity Values

Structure	**Allowable Bearing Capacity (lb/ft^2)**
Water Tank Mat Foundation	1,500
Incubation Bldg./Head Box Structure (Isolated Pads)	2,000
Incubation Bldg. (Continuous Strip Footings)	2,000
Head Box- Concrete Mat Foundation	1,500
Reuse Treatment Structure Mat Foundation	1,500
Wastewater Clarifier Mat Foundation	1,200

5.3 FOUNDATION SETTLEMENT

In addition to immediate elastic settlement due to imposed loads of the structures during construction and loading, primary consolidation settlements of clay layers beneath the proposed foundations were estimated. Consolidation settlement will occur over time, as discussed below. Our analyses used the results of one-dimensional consolidation testing on a relatively undisturbed sample clay soil obtained in borehole B-3.

Primary consolidation is a time-dependent phenomenon that occurs due to the reduction in volume of a soil mass caused by a sustained load applied on the mass. The volume reduction is caused by the squeezing out of water under pressure from the pore spaces between the soil particles. The primary consolidation continues until the excess pore water pressure is completely dissipated and is followed by a transfer of the load from the pore water to the soil particles.

Based on one-dimensional consolidation theory and rigid foundation assumptions we estimate the primary consolidation settlement for foundations designed and constructed as described in Section 6 will be as shown in **Table 6**. These settlements do not include the estimated immediate settlements of the structures which have all been estimated to be less than 1/4 inch.



Table 6: Estimates of Primary Consolidation Settlement

Structure	Settlement (in.)
Well Water Tank	0.3
Wastewater Clarifier Tank	0.3*
Northwestern Portion of Rearing Tanks	< 0.1 to 0.1
Southeastern Portion of Rearing Tank	0.1 to 0.2
Incubation Building Continuous Strip Footing	0.3

*value assumes uniform thickness of clay beneath the tank, which may be an conservative assumption if tank is constructed at current proposed location.

Settlement estimates in the above table are for the structures believed to be the most susceptible to measurable total settlement. Differential settlement of spread footings supporting the incubation building are estimated to be approximately ½ of the total estimated settlement. If structures are to be rigidly connected via pipes, design features should be considered that mitigate potential negative effects of differential settlement between the structures.

If the mat foundations bearing directly on the native, undisturbed clay material cannot be considered rigid, the soil pressure distribution should be computed using a method which models the soil-structure interaction, such as a beam on an elastic foundation procedure. A modulus of vertical subgrade reaction (k_s)equal to 40 pci may be used. This modulus value given is for a 1-foot square plate and must be scaled appropriately for mat shape and size.

5.4 SEISMIC PARAMETERS

The collected geotechnical field and laboratory data indicate that the subsurface profile for the site fall in Site Class D per ASCE 7-16.

In accordance with the International Building Code (IBC, 2018), the proposed incubation building is classified as Risk Category II. This category contains structures such as residential, commercial, and industrial buildings which are not conforming to another category (IBC, 2018).

Table 7 summarizes the seismic parameters for Site Class D.

Table 7: Seismic Criteria for Design

Seismic Criteria	Value
Mapped Spectral Response Acceleration for Short Periods S_s (g)	1.205
Mapped Spectral Response Acceleration for 1-second Period S_1 (g)	0.43
Maximum Considered Earthquake Spectral Acceleration for Short Periods S_{MS} (g)	1.227
Maximum Considered Earthquake Spectral Response Acceleration for 1-second Periods S_{M1} (g)	0.804*
5-percent Design Spectral Response Acceleration for Short Periods S_{DS} (g)	0.818
5-percent Design Spectral Response Acceleration for 1-second Periods S_{D1} (g)	0.536*
Site Coefficient F_a	1.018
Site Coefficient F_v	1.87*
Site Modified Peak Ground Acceleration, $PGA_m = F_{PGA} \times PGA$	0.567

Note * These value can be used only if requirements of ASCE 7-16 Section 11.4.8 Exception 2 is fulfilled.

5.5 FRICTION COEFFICIENT AND PASSIVE PRESSURE RESISTANCE

The lateral resistance of the structures constructed on natural, undisturbed soil will be a combination of the sliding resistance of the foundation on the subgrade materials and passive lateral earth pressure against the sides of the foundation. Resistance to sliding at the bottoms of the cast in place concrete foundations on medium stiff and stiff clay should be calculated based on a coefficient of friction of 0.23. For the cast in place pumped water intake structure founded on very dense granular sol, a coefficient of friction of 0.35 should be used. These values are working values having a factor of safety (FoS) value of 1.5 applied.

Passive pressure resistance against the sides of the foundations or structures can be calculated using an equivalent fluid unit weight of in-situ clay. Equivalent fluid weights for the moist in-situ clay and other materials that may present or placed against these features are summarized in **Table 7.** These values are working values having been reduced from calculated ultimate values to account for the significant strain that would be required to fully mobilize the ultimate values as well as provide strain compatibility with resistance to sliding by base friction.

The lateral resistance of the spread, strip, and mat footings supporting some or all of the water intake structure, incubation building, circular rearing tanks, and wastewater clarifier placed on granular structural backfill will be a combination of the sliding resistance of the footings on the foundation materials and passive earth pressure against the sides of the footings. Resistance to sliding at the bottoms of the mass

concrete footings on structural backfill can be calculated based on a coefficient of friction of 0.39. Passive pressure against the sides of the footings can be calculated using an equivalent fluid unit weight of granular structural backfill which is summarized in **Table 7**.

Table 8: Equivalent Fluid Weights

Material	Equivalent Fluid Weight (pcf)
Moist In-Situ Clay Outwash	160
Moist In-Situ Granular Outwash	220
Moist Granular Structural Backfill	210
Saturated In-Situ Granular Outwash	180
Saturated Granular Structural Backfill	180

5.6 HYDRAULIC UPLIFT OF PUMPED INTAKE STRUCTURE

The normal operating level of impounded water around the pumped intake structure is planned to be 7.0-ft above the base of the pumped intake structure. This water level could raise during the life of the structure, particularly after extended periods of precipitation and as the impounded level in the creek varies. However, we understand the normal operating conditions for the structure include the structure being filled with water through hydraulic connection with Battle Creek. Uplift pressures acting at the base of the structure should be analyzed If unwatering of the structure could occur during its design life (for example during construction or maintenance). No hydostatic uplift calculations were performed as part of this scope.

All structures besides the pumped intake structure are planned to be constructed above the water table. Hydraulic uplift is not believed to be a concern for those structures.

6.0 FINDINGS AND RECOMMENDATIONS

6.1 PRINCIPAL FINDINGS

- The project area is within a seismically active zone, and the closest active fault is located within 7.5 miles of the site. There is a high of tsunami hazard risk at the site. Geohazards of fault rupture, soil liquefaction and associated lateral spreading, flooding, and volcanic lava and lahar flow were evaluated and not considered to be a risk for the project.
- Very dense, granular soils were encountered in this study to our explored depths of 31.5 feet bgs. Above this material 7 to 12 feet of lean clay was present. Groundwater was generally consistent with the elevation of Battle Creek at the time of drilling, ranging in elevation between El. 22 and 25.
- The subsurface conditions are suitable for support of the mat foundations for the well water storage tank, headbox, incubation water reuse pump station, rearing tanks, reuse treatment structure, and wastewater clarifier. The subsurface conditions are also suitable for the spread footing and strip foundations for the incubation building and headbox. Estimated total settlements of these structures using the recommended allowable bearing capacities are less than ½ inch.
- If the water intake structure is to be unwatered at any point in its design life (i.e. maintenance), uplift pressures beneath the structure should be analyzed to ensure an adequate factor of safety against uplift. The remaining proposed structures will be above the observed groundwater level.
- Global slope stability analyses of the hillside along the project site was not performed as part of this study. No active or inactive landslides or localized slumps were observed in our cursory walk through of the project site.
- An originally-planned boring in the vicinity of the pumped intake structure was not able to be performed during the study. Temporary shoring and dewatering of soils around the proposed excavation for the structure will require design by a professional engineer licensed in the State of Washington. Bidding contractors for the work may not have sufficient data in this location to base their contract bid costs without building in relatively higher contingencies to account for cost risk at this structure. It is recommended the construction contract bidding phase include a required test pit be performed at this location. Alternatively, it is recommended that a supplemental test pit along the creek bank be considered during the design stage when the final location is selected. This option could substantiate temporary slope design assumptions that the soils within the bank are consistent with the granular soils encountered elsewhere at the site in this elevation range. Additionally, this option could provide a thickness of the younger alluvium that is appears present within the creek channel.



6.2 DESIGN AND CONSTRUCTION RECOMMENDATIONS

6.2.1 Structure Foundations and Slabs

6.2.1.1 Foundation and Floor Slab Subgrade Preparation

"Subgrade" is the native, undisturbed soil onto which structures or the underlying structural fill will be founded upon. In most areas, the existing topsoil and gravel roadway will need to be removed to reach the subgrade. Subgrades of the proposed structures should be properly prepared.

The subgrades should be proof-rolled to identify soft, yielding surfaces. This can be performed with heavy construction equipment having pneumatic rubber tires (i.e. water trucks, front-end loaders, dump trucks). Alternatively, a 1/8-inch diameter steel rod can be used as a probe by pushing it manually into the soil in areas of difficult access (i.e. spread footings). Soft or yielding zones should be excavated and replaced with structural backfill.

The prepared subgrades should be protected from excessive drying or wetting prior to placing structural fill or structures. A mudmat, cast on top of native soil subgrades, should be required beneath foundations and floor slabs to protect the prepared subgrades from precipitation and construction disturbance. A geotechnical engineer should be required to observe the proof rolling and review the condition of prepared subgrade surfaces. In order to achieve satisfactory compaction of the subgrade and fill materials, adjustment of the water content may be necessary at the time of construction. This may require water be added to soil that is too dry, or the scarification and aeration of soils that are too wet. If soft or yielding zones are not able to practically be excavated to a firmer subgrade, we recommend that these subgrades be reinforced with a biaxial geogrid (Tensar BX1200) placed below a minimum 8-inch layer of nominal ¾-inch crushed rock. This reinforcement would require that geogrids be placed at least 10 feet beyond the poor subgrade and the materials be installed per supplier's recommendations.

Care should be taken when excavating the foundations to avoid disturbing the supporting clay materials. Excavation methods which minimize soil disturbances, such as hand excavation or careful soil removal with a backhoe positioned outside of the excavation material may be required.

6.2.1.2 Mat Foundations

As discussed in Section 5.3, rigidity of the mat(s) is dependent on the mat dimensions, column spacing, rigidity of the superstructure, and modulus of subgrade reaction of the supporting soil. We recommend the designed foundation be evaluated to determine if the rigidity assumption is valid; the mat rigidity will be a function of its thickness, dimensions, degree of reinforcement and spacing of internal vertical loads (i.e. columns/equipment). If the mat cannot be considered to be rigid, the soil pressure distribution should be computed using a method which models the soil-structure interaction, such as the beam on an elastic foundation procedure.



6.2.1.3 Shallow Foundations

Isolated pads described for the proposed structures should be constructed with a minimum width of 30 inches. Strip footings should be constructed with a minimum width of 24 inches. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations a minimum of 18 inches is typically used in this area (Snohomish County, 2017).

Specifications should required that if areas of soft material are encountered at the base of excavated subgrades, the material is to be removed and footings excavated to adequate natural bearing material. As an alternate, the soft material may be removed and replaced with structural fill compacted to the requirements described in Section 6.2.6 This new structural fill should extend down from the edges of the footings at a 1H:1V projection.

6.2.1.4 Rearing Tanks

Based on the proposed elevations of the bases of the rearing tanks, it appears that at most 2 to 3 feet of structural fill will need to be placed on the preparing existing ground surface (i.e. stripped of topsoil and soft soils). Based on the thicknesses of clay material that are anticipated to be present beneath the proposed tanks, we estimated in Section 5.3 that between 1/8 and 1/4 inch of differential settlement could occur between tank elevations across the gridded layout of tanks. Designers should consider if this amount of differential settlement between tanks is acceptable for proper performance of the hydraulically connected tanks. If this amount of estimate settle is unacceptable, this settlement can be mitigated by removing the entirety of clay material present and replacement of structural fill.

6.2.1.5 Wastewater Clarifier Tank

The currently planned location of the wastewater clarifier tank is along the creek bank slope. Due to the likelihood of softer soils (colluvium from slope mass wasting) being present at shallower depths closer to the surface of the slope, differential settlement of the downhill side of the tank is a concern. It is recommended that the tank be situated on a uniformly stiff subgrade; situating the proposed tank such that the downhill side of the tank is at least 4 feet into the existing slope face would likely provide this desired uniform subgrade.

6.2.2 Soil Corrosivity

Water-soluble sulfate testing was performed on a sample of soil obtained from borehole B-2 at 5 and 15 feet bgs. The measured water-soluble sulfate content of both samples was less than 0.0002%. This value represents a “negligible” degree of sulfate attack to concrete exposed to these materials according to criteria presented in the U.S. Bureau of Reclamation Concrete Manual. Based on this information, we believe special sulfate resistant cement will not be required for concrete exposed to these soils.



Soil pH, soil electrical resistivity (saturated), and chloride content testing was also performed on this same soil sample for consideration of the design team when evaluating the potential for buried metal corrosion. The results are presented in **Table 9**. The acidity of the soil assessed by pH indicate that the soils are slightly acidic and slightly basic and will not accelerate corrosion. The electrical resistivity measurements of saturated soil specimens indicate that these soils tested are classified as having good to excellent corrosion resistance.

Table 9. Results of Soil Corrosivity Laboratory Testing

Laboratory Test	Sample B-2 at 5-ft	Sample B-2 at 15-ft
Chloride Content	<2 mg/kg	<2 mg/kg
Sulfate Content	<2 mg/kg	<2 mg/kg
pH	6.8	7.3
Electrical Resistivity (Saturated)	3,129 Ohm-cm	8,366 Ohm-cm

6.2.3 Temporary Slopes and Shoring

Excavations for the pumped intake structure will be up to approximately 20 feet deep. For non-engineered slope excavations (less than 20 feet), the contractor is required to construct and maintain slopes according to OSHA guidelines; the contractor is responsible for identifying the OSHA soil types and configurations of their excavations. For civil layout design purposes only (e.g. evaluating potential encroachments of excavations into existing utilities and other permanent features), Stantec designers should assume that the on-site granular soils (typically encountered at depth in the boreholes performed at higher elevations) are present at the ground surface of the existing parking lot. Designers should assume that the temporary slope above the intake structure is comprised of OSHA Type C soils. This soil type is recommended for use in laying out temporary slopes due to their anticipated coarse-grained nature and propensity for seeps to exit the excavated slope when the slope toe is unwatered. OSHA Type C simple slopes (less than 20 feet) have a maximum allowable slope of 1.5H:1V. We recommend that Stantec's geotechnical engineer evaluate temporary slopes to be indicated on drawings during the design phase of this project

If excavations will generally be deeper than 20 feet, the contract documents should require the Contractor to submit a temporary excavation and shoring plan for the proposed structure that is designed and stamped by a registered professional engineer in the State of Washington.

Stantec recommends that the contractor be required to be familiar with applicable local, state, and federal regulations for both temporary construction slopes and shoring, including current OSHA Excavation and Trench Safety Standards. Stantec further recommends that the contractor be contractually identified as

solely responsible for the design and construction of temporary construction slopes and shoring associated with construction of the pumped intake structure.

The contractor should review the available borings and associated laboratory testing to develop estimates of soil unit weight and drained/undrained shear strengths for use in their design of temporary layback slopes and/or shoring systems.

6.2.4 Permanent Slopes and Site Grading

Stantec understands that permanent cuts and fills associated with site grading for the project will be less than 5 feet. It is recommended that permanent slopes associated with site grading be 2H:1V or shallower to limit sloughing and raveling of the ground over time. Flatter slopes may be needed if groundwater seepage exiting the slope face is anticipated or observed during construction.

Excavation appears required to achieve the proposed base elevations of the northern portion of the rearing tanks. It is recommended that structural fill be used to raise the subgrade of the southern portion of the rearing tanks; the structural fill should be placed such that its placement provides support to the rearing tanks within a 1.5H:1V projection from the outside edges of the outermost tanks.

All areas subjected to grading should have topsoil removed. Trees will need to be removed and stumps ground down prior to grubbing. Brushy forest undergrowth and root systems of trees will need to be fully grubbed.

The natural (fine-grained) soils will likely pump or deform excessively under heavy construction traffic after periods of wet weather, as we discussed in Section 4.1. Construction equipment should be selected to avoid this difficulty and planning of earthworks should consider the potential effects of wet weather on construction schedule. The use of track-mounted construction equipment is normally recommended since the tracks will exert lower contact pressures than pneumatic tires. The movement of the vehicles over proposed foundation areas should be restricted to limit the tendency for equipment to deteriorate the subgrade conditions prior to placing concrete.

6.2.5 Construction Dewatering/Shoring at Pumped Intake Structure

Since construction to be carried out at the water intake structure is anticipated to be below the creek water level and observed groundwater level in the adjacent slope, it is anticipated that dewatering efforts will be needed during construction within a shoring system surrounding the excavation. This creek and groundwater are likely to be present at all seasons of the year. Stantec recommends that the contractor be required to maintain the groundwater level at least 2 feet below the advancing excavation elevation while advancing down to the subgrade elevation. Failure to lower the phreatic surface within the area below the advancing excavation surface could result in unnecessary disturbance of the subgrade when it

is reached. The contractor should also be required to demonstrate that any temporary dewatering employed will not negatively affect the existing nearby diversion dam.

We anticipate that a shoring system will be needed around the perimeter of the work to accommodate up to 9 feet of excavation to reach the intake subgrade. Based on the subsurface conditions encountered in borings performed at the rearing tanks, it appears that coarse-grained deposits could be present below the more-recent sediments that have accumulated within the creek channel (estimated to be on the order of 5 to 10 feet thick). The coarse-grained deposits are likely present at depths of embedment required of cantilevered shoring systems. No drill holes have been performed in this area; therefore, factual data of the conditions at this location are unknown. Assuming these conditions described, it seems cantilevered, interlocking sheetpiles advanced to typical embedment depths would be a practical option for shoring and mitigating seepage flow rate up into the excavation. Caution should be exercised when making this assumption, as the coarse-grained soils in this area are typically very dense and contain gravels which could pose difficulties in vibrating or hammering sheets to the assumed required embedment depths below the excavation of about 15 feet.

We recommend that the contractor be responsible for the design and installation of dewatering and shoring systems and a dewatering and shoring plan be a required submittal as part of the contract and stamped by a registered professional engineer in the State of Washington. The contractor should review the available boring logs and associated laboratory testing for use in developing estimates of hydraulic conductivity, storativity, and porosity of the soils to be dewatered.

Groundwater is not anticipated to be encountered during excavations of the remaining identified proposed structures; other than this pumped water intake structure.

6.2.6 Fill and Compaction Requirements

We recommend that structural fill be placed underneath all paved areas and structures where additional fill is required to reach structure subgrades. General backfill may be used elsewhere using on-site soils. The stripped, organic-rich material may be stockpiled separately and used in landscaping areas that will not receive any structures in the future

It is recommended that the general fill materials be selected or processed fine earth, rock, gravel, or sand excavated from the site with a maximum particle size less than 3 inches. All fill shall be free from grass, roots, brush, other vegetation, organic matter, frozen soils, and contaminated soils. It is recommended that soils that classify as Pt, OH, OL, MH, and CH should not be used as general fill. The Contractor should be aware that the upper lean clay (CL) materials present at the site will require strict moisture control during earthwork which may be challenging and time-consuming in rainy months of the year.

Provisions should be made in the contract documents to require proper disposal of soil not suitable for use, indicating whether materials may be disposed of on- or off-site.

Stantec recommends the structural fill be imported to the site and conform to the requirements listed in **Table 10.** Designers could alternatively use the gradation requirements of "Type A- 3/4-inch minus) materials as standardized in Stantec's 31 30 00 specification for use on this project.

Table 10. Criteria for Structural Fill

Criteria	Description
Plasticity Index	Less than 12%
Liquid Limit	Less than 40%
Percent Passing No. 4 sieve	20% to 100%
Percent Passing No. 40 sieve	Less than 60%
Percent Fines (percent passing #200)	Less than 10%
Maximum Particle Size	1½ inches

It is recommended that imported structural fill materials be reviewed and approved by the Engineer before being brought to the site. It is recommended that all fill placed within 6 inches of any structure or pipe will not be allowed to contain rocks or lumps larger than 3 inches in the greatest dimension, with not more than 15 percent larger than 2.5 inches.

Where referenced in this report, use the ASTM D698 test method to establish relative compaction and optimum moisture content. It is recommended that structural fill underneath paved areas and structures be compacted to at least 98 percent of the maximum dry density (MDD). It is recommended that general backfill not underneath paved areas and structures be compacted to at least 93 percent of the MDD. Compaction recommendations for fill are presented in **Table 6**.

Table 11. Compaction Requirements for Fill

Item	Criteria
Lift Thickness	<6 inches (compacted)
Density (nonstructural areas)	≥93% MDD
Density (structural areas)	≥98% MDD
Moisture Content	Minus 2% points to plus 2% points of optimum

7.0 LIMITATIONS

Our findings, recommendations, and discussions presented herein are based upon an evaluation and interpretation of the findings from the field and laboratory programs, with interpolation and extrapolation of subsurface conditions between and beyond the exploration locations. This report contains information that is valid as of the report's date and to the extent directly known to Stantec. However, inherent in most projects performed in the heterogeneous subsurface environment, continuing subsurface explorations and analyses may reveal conditions that are different than those described in this report. No other warranty, expressed or implied, is made.

The findings, interpretations of data, recommendations, professional opinions, and conclusions that are presented are within the limits prescribed by available information at the time these analyses and this report were prepared, in accordance with generally accepted professional engineering practice. Variations from results presented in this report should be expected due to uncertainties that are inherent in these types of projects and analyses. Therefore, decisions that are based on these results should consider these variations as well as limitations of the analyses to predict future performance with a high degree of accuracy.

8.0 REFERENCES

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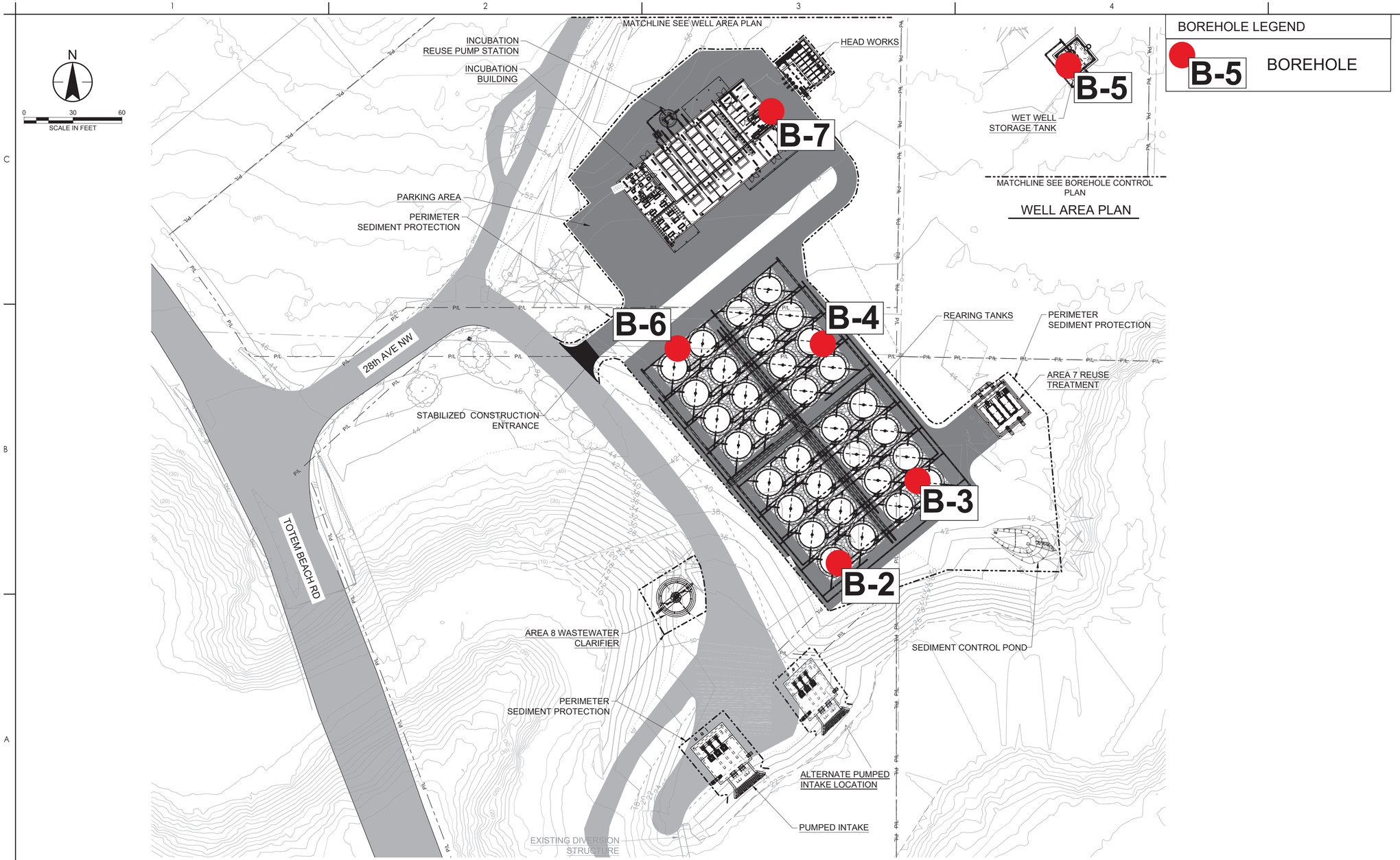
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FIGURE 1

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BATTLE CREEK EROSION AND SEDIMENT CONTROL PLAN

SCALE: 1:30

Revision | By | Appd | YYYY.MM.DD

Issued | By | Appd | YYYY.MM.DD

Permit/Seal

PRELIMINARY NOT FOR CONSTRUCTION

Not for permits, pricing or other official purposes. This document has not been completed or checked and is for general information or comment only.

WARNING
0 ½ 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

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Client/Project Logo

Client/Project
TULALIP TRIBES

BATTLE CREEK HATCHERY

File Name: 02267 1C-4 | ASK Dwn. | Dsgn. | CWS Chkd. | 2020.03.31 YYYY.MM.DD

Title
Figure 1-
Borehole Location Plan

Project No. 224202267
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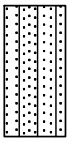
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APPENDIX A
BOREHOLE LOGS

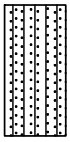
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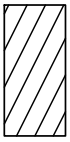
SILTY GRAVEL WITH SAND (GM); VERY DENSE; MEDIUM BROWN TO MEDIUM BROWNISH-GREY; DRY TO WET.



SILTY SAND WITH GRAVEL (SM); VERY DENSE; MEDIUM BROWN TO MEDIUM BROWNISH-GREY; DRY TO WET.



SANDY SILT (ML); HARD; NON-PLASTIC; MEDIUM BROWN; MOIST TO WET.



LEAN CLAY (CL); STIFF TO VERY STIFF; LOW TO MEDIUM PLASTICITY; MOIST; MEDIUM BROWN TO MEDIUM BROWNISH-GREY.

SS- STANDARD SPLIT SPOON SAMPLER: A HOLLOW SOIL SAMPLER DRIVEN BY A 140 LB. AUTOMATIC TRIP HAMMER DROPPED FROM A FREE FALL DISTANCE OF 30 INCHES WITH AN OUTSIDE DIAMETER OF 2 INCHES.

CAL- MODIFIED CALIFORNIA SAMPLER: A HOLLOW SOIL DROPPING FROM A FREE FALL DISTANCE OF 30 INCHES SAMPLER DRIVEN BYA 140 LB. AUTOMATIC TRIP HAMMER WITH AN OUTSIDE DIAMETER OF 3 INCHES.

ST- SHELBY TUBE SAMPLER: A THIN WALLED, HOLLOW SOIL SAMPLER HYDRAULICALLY PUSHED TO EXTRACT A RELATIVELY UNDISTURBED SAMPLE WITH A DIAMETER OF 3 INCHES.

Stantec	BATTLE CREEK HATCHERY PROJECT	LEGEND	FIGURE 1

GEOTECHNICAL LOG OF DRILL HOLE NO. B-2

FEATURE: REARING TANK/ INTAKE
PROJECT: BATTLE CREEK HATCHERY
STATE: WASHINGTON

LOCATION: SE CORNER OF TANKS
COORDINATES: 48° 3' 25.55" N, 122° 16' 13.88" W
GROUND ELEVATION: 42'

BEGUN:9/17/2020 FINISHED: 9/17/2020
TOTAL DEPTH: 21.5'
ANGLE FROM HORIZ: 90
AZIMUTH: N/A

GROUNDWATER DEPTH DURING/AFTER DRILLING: 20'
HOLE LOGGED BY: ZACHARY HAFFENREFFER, EIT
CHECKED BY: Z. HAFFENREFFER, EIT

REVIEWED BY: J. WORTHEN, PE

NOTES	DEPTH (FT)	SAMPLE TYPE / RECOVERY (%)	STANDARD PENETRATION TEST / BLOWS PER FOOT 140lb HAMMER - 30IN DROP (0 10 20 30 40 50)	FIELD CLASS/LITH	GEOL UNIT SYMBOL	CLASSIFICATION AND PHYSICAL CONDITION
SPT BLOW COUNTS 5-7-9 8' driller noted gravelly drilling SPT BLOW COUNTS 31-41-41 SPT BLOW COUNTS 30-50/4" SPT BLOW COUNTS 35-50/5"	5 10 15 20 25 30 35 40 45	SS 100 SS 100 SS 100 SS 100	(16) (50+) (50+) (50+) BOTTOM OH HOLE: 21.5 FEET	(CL) (GM) (SM) (SM)		0.0-8.0' CLAY RECESSIONAL OUTWASH GENERALLY CONSISTS OF MOIST VERY STIFF LEAN CLAY (CL). 5.0-6.5': very stiff clay (CL); about 5% fine sand; about 95% medium plasticity clay; medium gray to medium brown; moist; 4.5 tsf ucs; hard. **8.0-21.5' GRANULAR RECESSIONAL OUTWASH** GENERALLY CONSISTS OF DRY TO WET VERY DENSE SILTY SAND WITH GRAVEL (SM) TO SILTY GRAVEL WITH SAND (GM) WITH VARIABLE AMOUNTS OF SILT, SAND, AND GRAVEL WITH GRAVEL UP TO 1 IN. IN SIZE BASED ON SAMPLES OBTAINED. 10.0-11.5': very dense silty gravel with sand (GM); about 50% rounded gravel to 1.0 in.; 30% coarse to fine sand; 20% silt; moist; medium gray to medium brown. 15.0-16.5': very dense silty sand with gravel (SM); 20% rounded gravel to 1 in.; 60% fine to coarse sand; 20% silt; dry; medium brownish-gray. 20.0-21.5': very dense silty sand with gravel (SM); 7% grounded gravel to 1/2 in.; 55% coarse to fine sand; 38% silt; wet; medium brownish-gray.

COMMENTS

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BATTLE CREEK HATCHERY PROJECT

GEOTECHNICAL LOG OF DRILL HOLE NO. B-2

FIGURE 2

GEOTECHNICAL LOG OF DRILL HOLE NO. B-3

FEATURE: REARING TANKS
PROJECT: BATTLE CREEK HATCHERY
STATE: WASHINGTON

LOCATION: E CORNER OF TANKS
COORDINATES: 48° 3' 26.06" N, 122° 16' 13.14" W
GROUND ELEVATION: 43'

BEGUN:9/17/2020 FINISHED: 9/17/2020
TOTAL DEPTH: 26.5'
ANGLE FROM HORIZ: 90
AZIMUTH: N/A

GROUNDWATER DEPTH DURING/AFTER DRILLING: 25'
HOLE LOGGED BY: ZACHARY HAFFENREFFER, EIT
CHECKED BY: Z. HAFFENREFFER, EIT

REVIEWED BY: J. WORTHEN, PE

NOTES	DEPTH (FT)	SAMPLE TYPE / RECOVERY (%)	STANDARD PENETRATION TEST BLOWS PER FOOT 140lb HAMMER - 30IN DROP (0 10 20 30 40 50)	FIELD CLASS/LITH	GEOL UNIT SYMBOL	CLASSIFICATION AND PHYSICAL CONDITION
7' driller noted gravelly drilling	5	ST		(CL)		**0.0-7.0' CLAY RECESSIONAL OUTWASH** GENERALLY CONSISTS OF MOIST STIFF LEAN CLAY (CL). **7.0-26.5' GRANULAR RECESSIONAL OUTWASH** GENERALLY CONSISTS OF DRY TO WET VERY DENSE SILTY SAND WITH GRAVEL (SM) TO SILTY GRAVEL WITH SAND (GM) WITH VARIABLE AMOUNTS OF SILT, SAND, AND GRAVEL WITH GRAVEL UP TO 3/4 IN. IN SIZE BASED ON SAMPLES OBTAINED. 10.0-11.5': very dense silty gravel with sand (GM); about 45% rounded gravel to 3/4 in.; about 15% fine to coarse sand; about 40% silt; moist; medium brown to medium gray. 15.0 to 16.5': hard sandy silt with gravel (ML); about 15% rounded gravel to 1/4 in.; about 15% fine to coarse sand; about 70% silt; moist; medium brown to medium gray; 2.5 to >4.5 tsf UCS. 20.0 to 21.5': very dense silty sand (SM); about 5% gravel; about 60% fine to coarse sand; about 35% silt; moist; medium gray. 25.0 to 26.5': very dense silty gravel (GM); about 70% rounded gravel to 1/4 in.; about 10% fine to coarse sand; about 20% silt; wet; medium gray.
SPT BLOW COUNTS 50/4"	10	SS 100	(50+)	(GM)		
SPTBLOW COUNTS 50/5"	15	SS 94	(50+)	(ML)		
SPT BLOW COUNTS 50"	20	SS 94	(50+)	(SM)		
SPT BLOW COUNTS50/1"	25	SS 100	(50+)	(GM)		
			BOTTOM OH HOLE: 26.5 FEET			
	30					
	35					
	40					
	45					

COMMENTS

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BATTLE CREEK HATCHERY PROJECT

GEOTECHNICAL LOG OF DRILL HOLE NO. B-3

FIGURE 3

GEOTECHNICAL LOG OF DRILL HOLE NO. B-4

FEATURE: REARING TANKS
PROJECT: BATTLE CREEK HATCHERY
STATE: WASHINGTON

LOCATION: NE CORNER OF TANKS
COORDINATES: 48° 3' 26.84" N, 122° 16' 14.09" W
GROUND ELEVATION: 47'

BEGUN:9/17/2020 FINISHED: 9/17/2020
TOTAL DEPTH: 31.5'
ANGLE FROM HORIZ: 90 AZIMUTH: N/A

GROUNDWATER DEPTH DURING/AFTER DRILLING: 25'
HOLE LOGGED BY: ZACHARY HAFFENREFFER, EIT
CHECKED BY: Z. HAFFENREFFER, EIT

REVIEWED BY: J. WORTHEN, PE

NOTES	DEPTH (FT)	SAMPLE TYPE / RECOVERY (%)	STANDARD PENETRATION TEST BLOWS PER FOOT 140lb HAMMER - 30IN DROP (0 10 20 30 40 50)	FIELD CLASS/LITH	GEOL UNIT SYMBOL	CLASSIFICATION AND PHYSICAL CONDITION
SPT BLOW COUNTS 5-5-8	5	SPT 94	(13)	(CL)		**0.0-12.0' CLAY RECESSIONAL OUTWASH** GENERALLY CONSISTS OF MOIST STIFF TO VERY STIFF LEAN CLAY (CL). 5.0 to 6.5': stiff lean clay (CL); about 5% fine sand; about 95% medium plasticity clay; moist; medium brown to medium gray; >4.5 tsf UCS. 10.0 to 11.5': very stiff lean clay (CL); about 5% coarse to fine sand; about 95% medium plasticity clay; moist; light brown to light gray; >4.5 tsf UCS.
SPT BLOW COUNTS 4-6-10 12' driller noted gravelly drilling	10	SS 100	(16)	(CL)		**12.0-31.5' GRANULAR RECESSIONAL OUTWASH** GENERALLY CONSISTS OF DRY TO WET VERY DENSE SILTY GRAVEL WITH SAND (GM) TO SILT WITH SAND (ML) WITH VARIABLE AMOUNTS OF SILT, SAND, AND GRAVEL WITH GRAVEL UP TO 1 1/2 IN. IN SIZE BASED ON SAMPLES OBTAINED. 15.0 to 16.5': very dense silty gravel (GM); about 50% rounded gravel to 1/4in.; about 10% coarse to fine sand; about 40% silt; moist; medium gray.
SPT BLOW COUNTS 19-50/2"	15	SPT 75	(50+)	(GM)		20.0 to 21.5': very dense silty gravel (GM); about 65% rounded gravel to 1 1/2 in.; 5% coarse to fine sand; 30% silt; moist; medium gray.
SPT BLOW COUNTS 42-50/3"	20	SPT 89	(50+)	(GM)		25.0 to 26.5': very dense silty gravel (GM); about 45% rounded gravel to 1/2 in.; 20% coarse to fine sand; 35% silt; wet; medium gray.
SPT BLOW COUNTS 50/3"	25	SPT 100	(50+)	(GM)		30.0 to 31.5': hard silt with sand (ML); about 20% rounded gravel to 1/4 in.; 25% coarse to fine sand; 55% silt; wet; medium gray.
SPT BLOW COUNTS 50/3"	30	SPT 100	(50+)	(ML)		
	35		BOTTOM OH HOLE: 31.5 FEET			
	40					
	45					

COMMENTS

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BATTLE CREEK HATCHERY PROJECT

GEOTECHNICAL LOG OF DRILL HOLE NO. B-4

FIGURE 4

GEOTECHNICAL LOG OF DRILL HOLE NO. B-5

FEATURE: WET WELL TANK
PROJECT: BATTLE CREEK HATCHERY
STATE: WASHINGTON

LOCATION: WET WELL TANK
COORDINATES: 48° 3' 29.69" N, 122° 16' 14.60" W
GROUND ELEVATION: 58'

BEGUN:9/18/2020 FINISHED: 9/18/2020
TOTAL DEPTH: 16.5'
ANGLE FROM HORIZ: 90
AZIMUTH: N/A

GROUNDWATER DEPTH DURING/AFTER DRILLING: NOT ENCOUNTERED
HOLE LOGGED BY: ZACHARY HAFFENREFFER, EIT
CHECKED BY: Z. HAFFENREFFER, EIT

REVIEWED BY: J. WORTHEN, PE

NOTES	DEPTH (FT)	SAMPLE TYPE / RECOVERY (%)	STANDARD PENETRATION TEST BLOWS PER FOOT 140lb HAMMER - 30IN DROP (0 10 20 30 40 50)	FIELD CLASS/LITH	GEOL UNIT SYMBOL	CLASSIFICATION AND PHYSICAL CONDITION
SPT BLOW COUNTS 4-10-14 7' driller noted gravelly drilling SPT BLOW COUNTS 50/5" SPT BLOW COUNTS 50/3"	5 10 15 20 25 30 35 40 45	SS 100 SS 80 SS 100	(24) (50+) (50+) BOTTOM OH HOLE: 16.5 FEET	(CL) (GM) (SM)		**0.0-7.0' CLAY RECESSIONAL OUTWASH** GENERALLY CONSISTS OF MOIST VERY STIFF LEAN CLAY (CL). 5.0-6.5': very stiff lean clay (CL); about 5% fine sand; about 95% medium plasticity clay; moist; medium brown to medium gray; >4.5 tsf UCS. **7.0-16.5' GRANULAR RECESSIONAL OUTWASH** GENERALLY CONSISTS OF DRY TO MOIST VERY DENSE SILTY SAND WITH GRAVEL (SM) TO SILTY GRAVEL WITH SAND (GM) WITH VARIABLE AMOUNTS OF SILT, SAND, AND GRAVEL WITH GRAVEL UP TO 1 1/2 IN. IN SIZE BASED ON SAMPLES OBTAINED. 10.0-11.5': very dense silty gravel with sand (GM); about 60% rounded gravel to 1 1/2 in.; 20% coarse to fine sand; 20% silt; moist; medium gray. 15.0-16.5': very dense silty sand with gravel (SM); about 30% rounded gravel to 1/2 in.; 40% coarse to fine sand; 30% silt; dry; medium gray.

COMMENTS

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BATTLE CREEK HATCHERY PROJECT

GEOTECHNICAL LOG OF DRILL HOLE NO. B-5

FIGURE 5

GEOTECHNICAL LOG OF DRILL HOLE NO. B-6

FEATURE: REARING TANK/ INCUBATION BUILDING

LOCATION: W CORNER OF TANKS

BEGUN:9/18/2020 FINISHED: 9/18/2020

GROUNDWATER DEPTH DURING/AFTER DRILLING: 20'

PROJECT: BATTLE CREEK HATCHERY

COORDINATES: 48° 3' 26.77" N, 122° 16' 15.50" W

TOTAL DEPTH: 31.5'

HOLE LOGGED BY: ZACHARY HAFFENREFFER, EIT

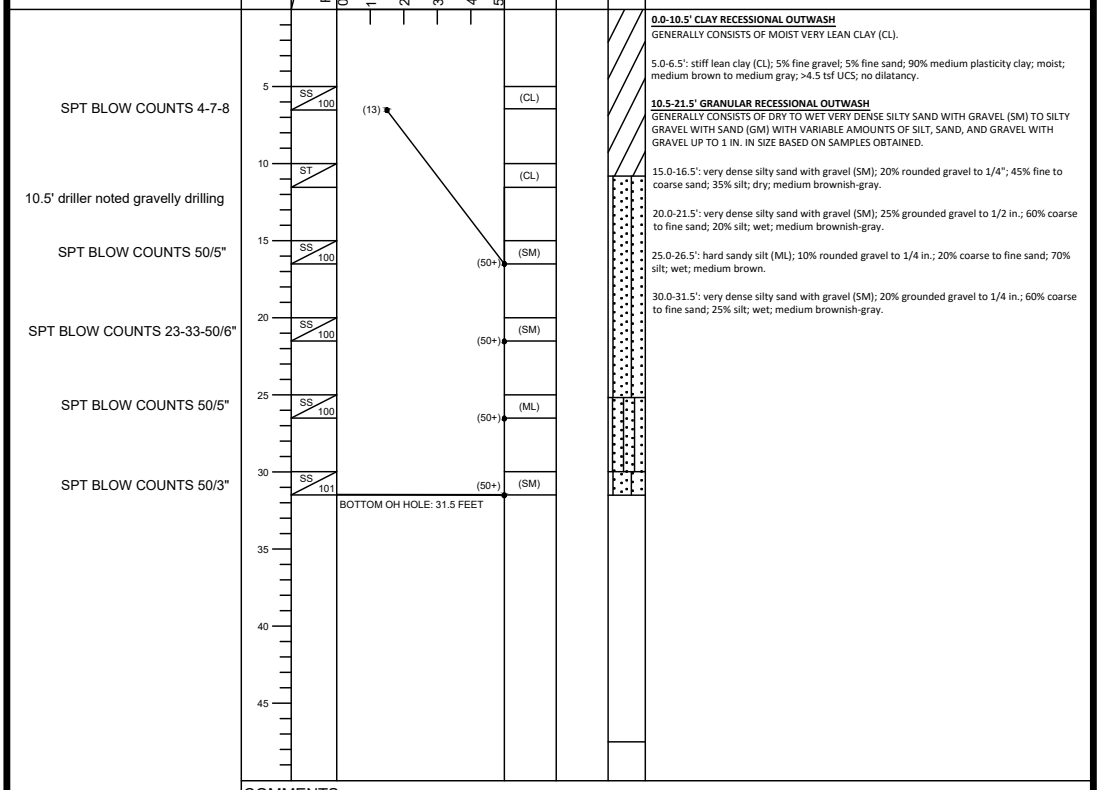
STATE: WASHINGTON

GROUND ELEVATION: 45'

ANGLE FROM HORIZ: 90 AZIMUTH: N/A

CHECKED BY: Z. HAFFENREFFER, EIT

REVIEWED BY: J. WORTHEN, PE



COMMENTS

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BATTLE CREEK HATCHERY PROJECT

GEOTECHNICAL LOG OF DRILL HOLE NO. B-6

FIGURE 6

GEOTECHNICAL LOG OF DRILL HOLE NO. B-7

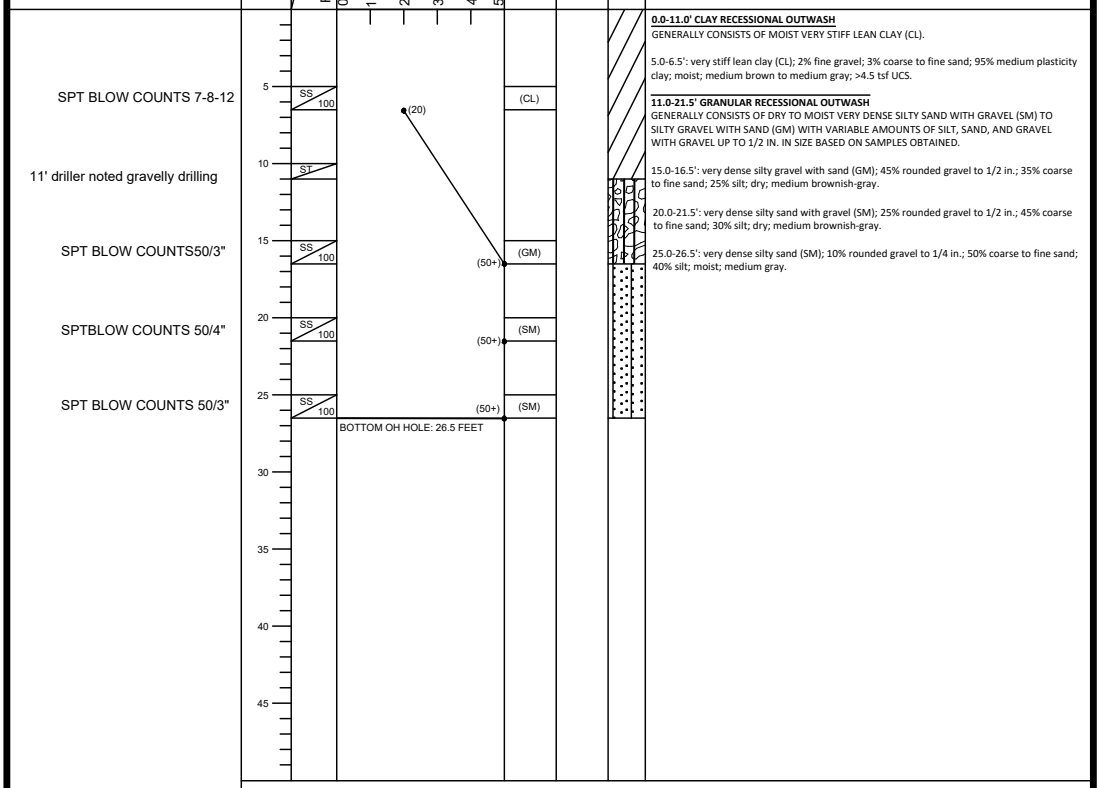
FEATURE: INCUBATION BLDG.
PROJECT: BATTLE CREEK HATCHERY
STATE: WASHINGTON

LOCATION: NE SIDE OF BLDG.
COORDINATES: 48° 3' 28.19" N, 122° 16' 4.67" W
GROUND ELEVATION: 49'

BEGUN:9/18/2020 FINISHED: 9/18/2020
TOTAL DEPTH: 26.5'
ANGLE FROM HORIZ: 90 AZIMUTH: N/A

GROUNDWATER DEPTH DURING/AFTER DRILLING: NOT ENCOUNTERED
HOLE LOGGED BY: ZACHARY HAFFENREFFER, EIT
CHECKED BY: Z. HAFFENREFFER, EIT

REVIEWED BY: J. WORTHEN, PE



COMMENTS

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BATTLE CREEK HATCHERY PROJECT

GEOTECHNICAL LOG OF DRILL HOLE NO. B-7

FIGURE 7

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APPENDIX B
SAMPLE PHOTOGRAPHS

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Borehole B-2, Split Spoon SPT Sample Beginning at 5 feet bgs



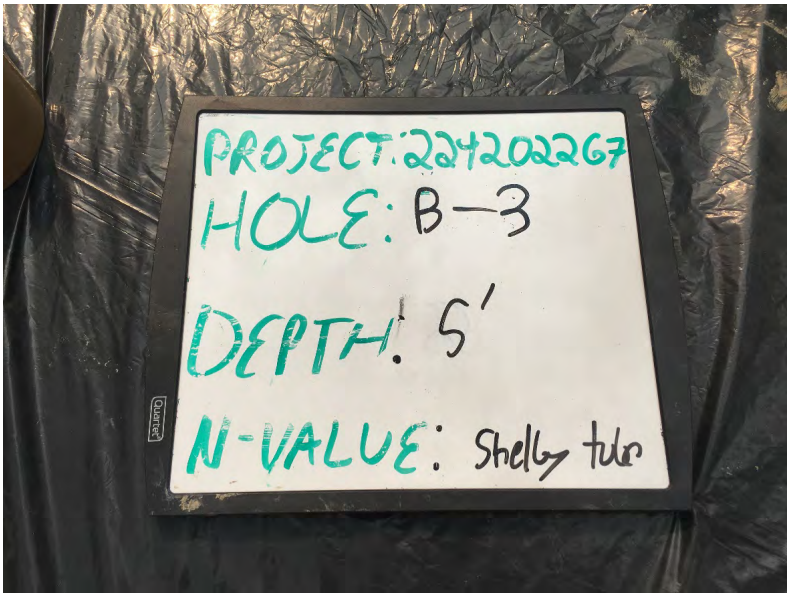
Borehole B-2, Split Spoon SPT Sample Beginning at 10 feet bgs



Borehole B-2, Split Spoon SPT Sample Beginning at 15 feet bgs



Borehole B-2, Split Spoon SPT Sample Beginning at 20 feet bgs



Borehole B-3, Shelby Tube Sample Beginning at 5 feet bgs



Borehole B-3, Split Spoon SPT Sample Beginning at 10 feet bgs



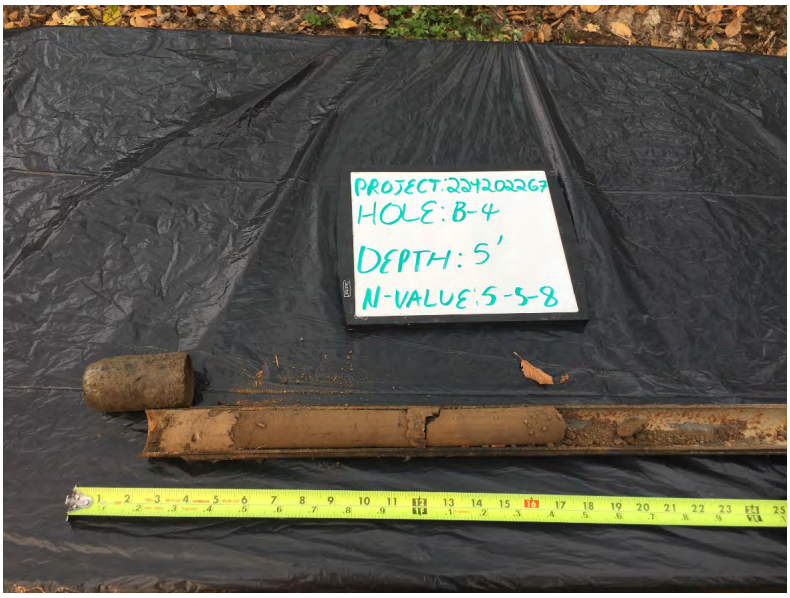
Borehole B-3, Split Spoon SPT Sample Beginning at 15 feet bgs



Borehole B-3, Split Spoon SPT Sample Beginning at 20 feet bgs



Borehole B-3, Split Spoon SPT Sample Beginning at 25 feet bgs



Borehole B-4, Split Spoon SPT Sample Beginning at 5 feet bgs



Borehole B-4, Split Spoon SPT Sample Beginning at 10 feet bgs



Borehole B-4, Modified California SPT Sample Beginning at 15 feet bgs



Borehole B-4, Split Spoon SPT Sample Beginning at 20 feet bgs



Borehole B-4, Split Spoon SPT Sample Beginning at 25 feet bgs



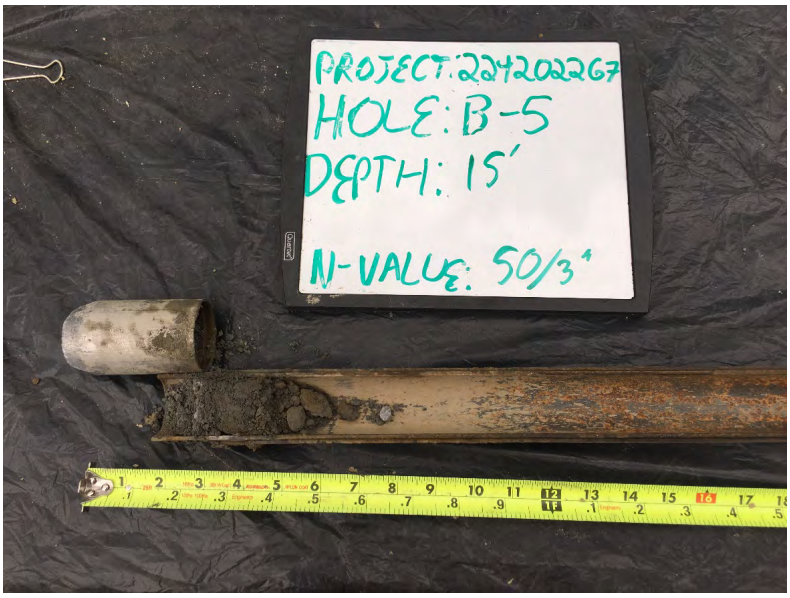
Borehole B-4, Split Spoon SPT Sample Beginning at 30 feet bgs



Borehole B-5, Split Spoon SPT Sample Beginning at 5 feet bgs



Borehole B-5, Split Spoon SPT Sample Beginning at 10 feet bgs



Borehole B-5, Split Spoon SPT Sample Beginning at 15 feet bgs



Borehole B-6, Split Spoon SPT Sample Beginning at 5 feet bgs

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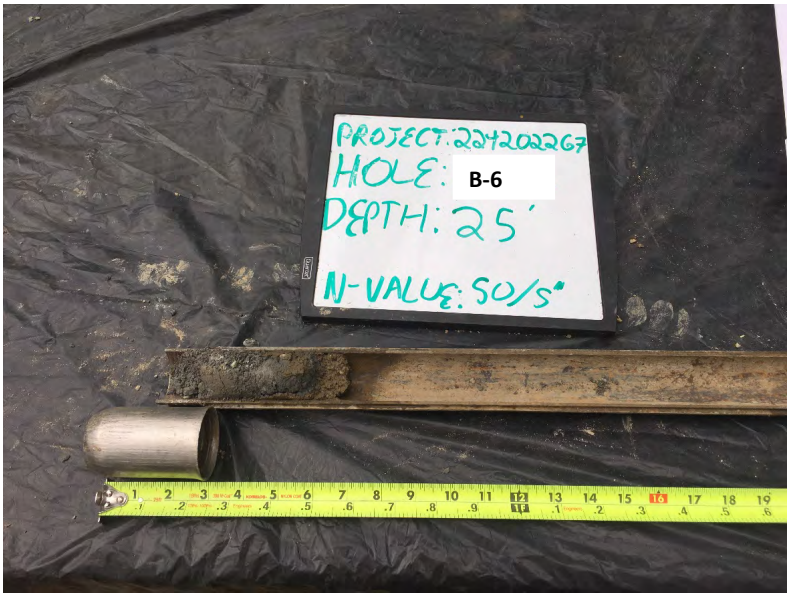
Borehole B-6, Shelby Tube Sample Beginning at 10 feet bgs



Borehole B-6, Split Spoon SPT Sample Beginning at 15 feet bgs



Borehole B-6, Split Spoon SPT Sample Beginning at 20 feet bgs



Borehole B-6, Split Spoon SPT Sample Beginning at 25 feet bgs



Borehole B-6, Split Spoon SPT Sample Beginning at 30 feet bgs



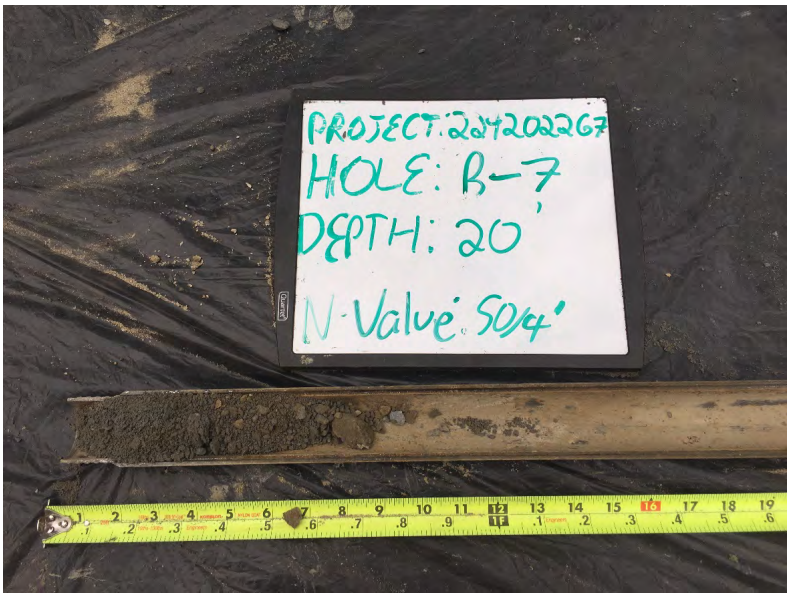
Borehole B-7, Split Spoon SPT Sample Beginning at 5 feet bgs

No image Available

Borehole B-7, Shelby Tube Sample Beginning at 10 feet bgs



Borehole B-7, Split Spoon SPT Sample Beginning at 15 feet bgs



Borehole B-7, Split Spoon SPT Sample Beginning at 20 feet bgs



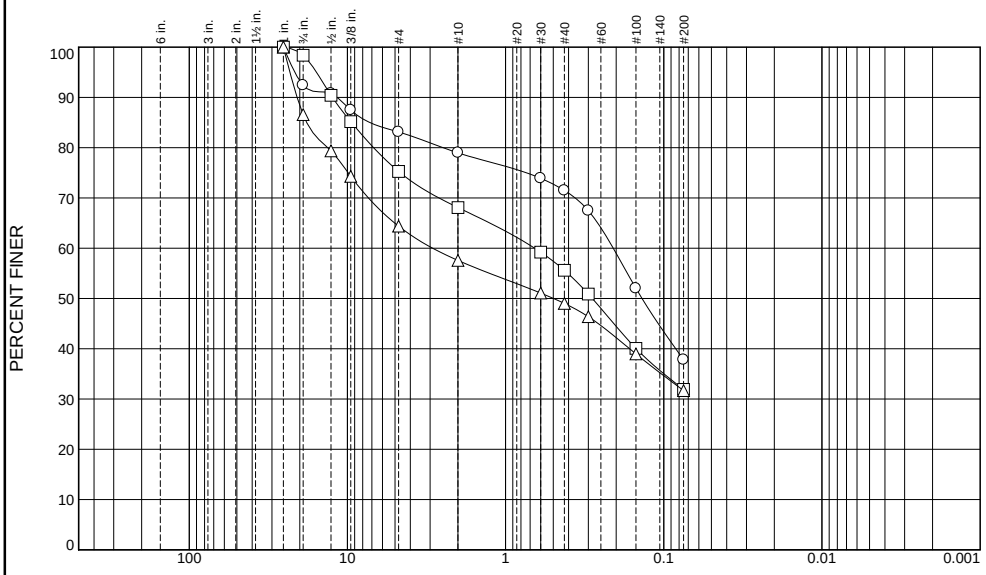
Borehole 0B-7, Split Spoon SPT Sample Beginning at 25 feet bgs

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APPENDIX C
LABORATORY TESTING RESULTS

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Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	16.9	45.3	37.8		SM	A-4(0)	NP	NP
□	0.0	24.7	43.4	31.9					
△	0.0	35.6	32.7	31.7					

SIEVE inches size	PERCENT FINER ○	□	△
1"	100.0	100.0	100.0
3/4"	92.4	98.4	86.6
1/2"	90.8	90.4	79.4
3/8"	87.5	85.2	74.3
GRAIN SIZE			
D_{60}	0.2087	0.6549	2.8960
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#4	83.1	75.3	64.4
#10	79.0	68.1	57.6
#30	73.9	59.2	51.1
#40	71.5	55.6	49.0
#50	67.5	50.9	46.4
#100	52.0	40.1	39.0
#200	37.8	31.9	31.7

Material Description

○ Gray Silty SAND w/ Gravel

□ Gray Silty SAND w/ Gravel

△ Gray Silty GRAVEL w/ Sand

REMARKS:

○ The sample size was small, relative to the largest particle size. This should be considered when interpreting this data.

□ The sample size was small, relative to the largest particle size. This should be considered when interpreting this data.

△ This sample was small and contained freshly fractured gravel. Results approximate.

○ Source of Sample: B-2 Depth: 20 Sample Number: B-2 20.0'

□ Source of Sample: B-3 Depth: 10 Sample Number: B-3 10.0'

△ Source of Sample: B-4 Depth: 15 Sample Number: B-4 15.0'

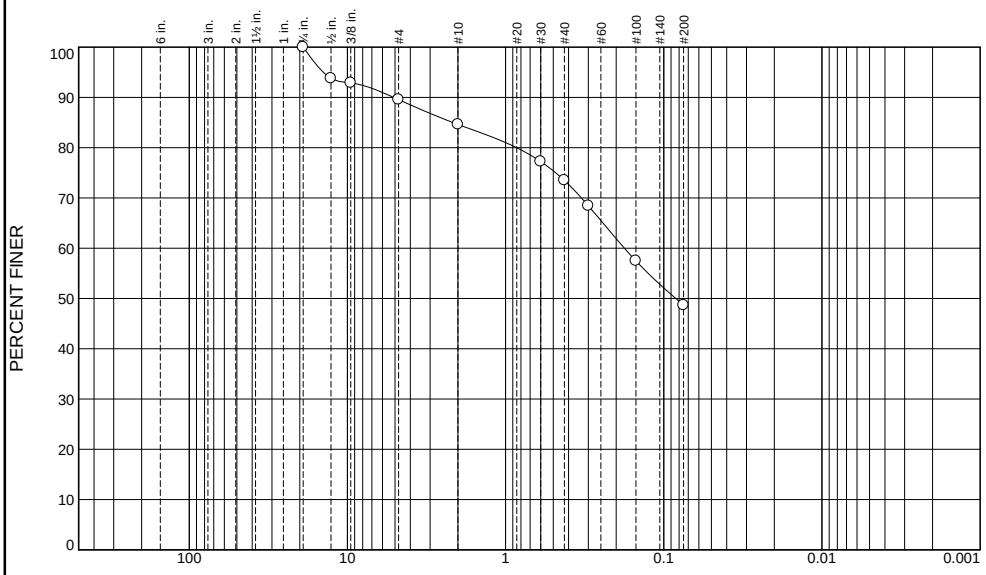
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Client: Stantec

Project: Tulalip Battle Creek - 224202267

Project No.: 045-009 Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	AASHTO	PL	LL
○	0.0	10.4	40.9	48.7					

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
1/2"	93.8		
3/8"	92.9		
	GRAIN SIZE		
D_{60}	0.1774		
D_{30}			
D_{10}			
	COEFFICIENTS		
C_C			
C_u			

SIEVE number size	PERCENT FINER ○		
#4	89.6		
#10	84.6		
#30	77.2		
#40	73.5		
#50	68.4		
#100	57.5		
#200	48.7		

Material Description
○ Gray Silty SAND

REMARKS:
○ This sample was small and contained freshly fractured gravel. Results approximate.

○ Source of Sample: B-7 Depth: 15 Sample Number: B-7 15.0'

Benchmark Geolabs, LLC

Client: Stantec
Project: Tulalip Battle Creek - 224202267
Project No.: 045-009 Figure

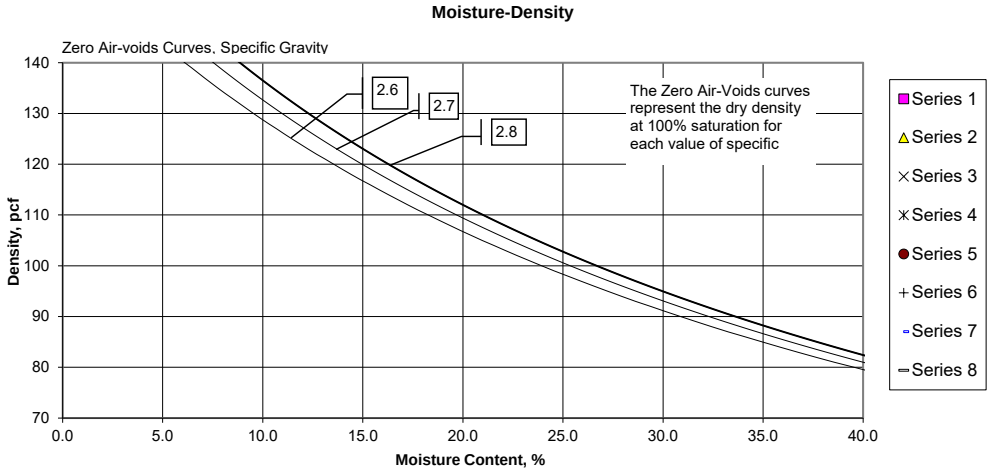
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Moisture-Density-Porosity Report
(ASTM D7263b)

BGL Job No:	045-009a	**Project No.**	224202267	**By:**	PJ
Client:	Stantec	**Date:**	10/29/20		
Project Name:	Tulalip Battle Creek	**Remarks:**			

Boring:	B-7	B-2	B-2	B-2	B-3	B-4	B-5	B-6
Sample:	B-7 5.0'	B-2 5.0'	B-2 10.0'	B-2 20.0'	B-3 10.0'	B-4 15.0'	B-5 5.0'	B-6 5.0'
Depth, ft:	5	5	10	20	10	15	5	5
Visual Description:	Pale Brown Lean CLAY	Mottled Brown Lean CLAY	Grayish Brown Silty SAND w/ Gravel	Gray Silty SAND w/ Gravel	Gray Silty SAND w/ Gravel	Gray Silty SAND w/ Gravel	Mottled Brown & gray Lean CLAY	Grayish Brown Lean CLAY
Actual G_s								
Assumed G_s								
Moisture, %	26.6	25.1	6.7	10.9	8.4	6.5	23.5	28.9
Wet Unit wt, pcf								
Dry Unit wt, pcf								
Dry Bulk Dens.ρb, (g/cc)								
Saturation, %								
Total Porosity, %								
Volumetric Water Cont,Θw,%								
Volumetric Air Cont., Θa,%								
Void Ratio								
Series	1	2	3	4	5	6	7	8

Note: All reported parameters are from the as-received sample condition unless otherwise noted. If an assumed specific gravity (Gs) was used then the saturation, porosities, and void ratio should be considered to be approximate.



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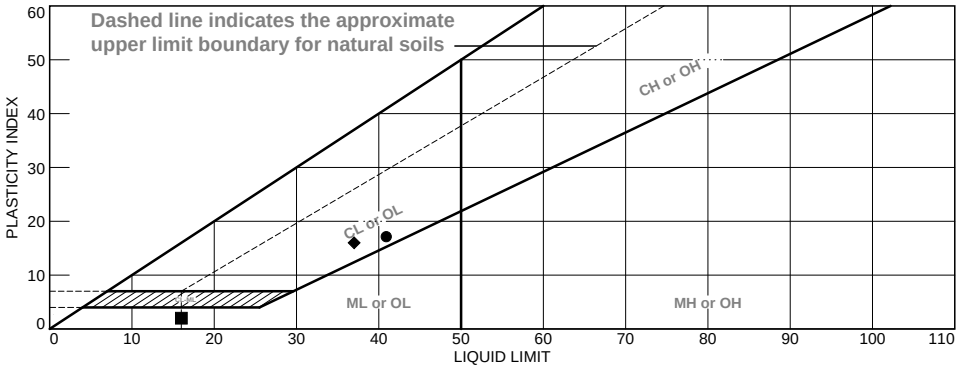
Percent Passing the No. 200
ASTM D1140

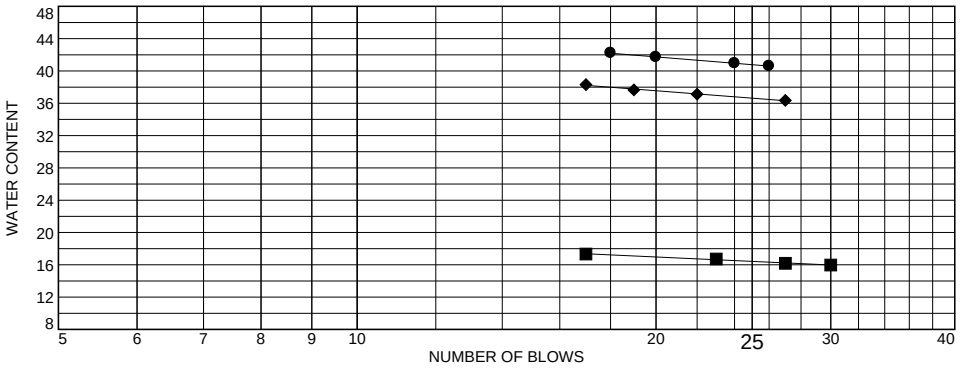
BGL Job No.:	045-009a	**Project No.:**	224202267	**Run By:**	PJ
Client:	Stantec	**Date:**	10/29/2020	**Checked By:**	PJ
Project:	Tulalip Battle Creek	Remarks:	B-2 10.0' - Small sample w/ freshly fractured gravel. Result approx.		

Boring:	B-6	B-3	B-7	B-7	B-2	B-2	B-5	B-6
Sample:	Shelby Tube	-	B-7 10.0'	B-7 5.0'	B-2 5.0'	B-2 10.0'	B-5 5.0'	B-6 5.0'
Depth, ft.:	10	-	10	5	5	10	5	5
Soil Type:	Mottled Gray CLAY	Pale Brown CLAY	Mottled Gray CLAY w/ Sand	Pale Brown Lean CLAY	Mottled Brown Lean CLAY	Grayish Brown Silty SAND w/ Gravel	Mottled Brown & Gray Lean CLAY	Grayish Brown Lean CLAY
Wt of Dish & Dry Soil, gm	166.1	173.7	162.9	151.0	166.2	477.4	174.4	175.1
Weight of Dish, gm	43.2	43.8	42.1	43.4	42.1	127.2	43.2	41.6
Weight of Dry Soil, gm	122.9	129.9	120.8	107.7	124.1	350.1	131.2	133.6
Wt. Ret. on #4 Sieve, gm	0.0	0.2	1.0	0.5	0.2	110.9	0.0	0.4
Wt. Ret. on #200 Sieve, gm	6.3	5.4	31.9	5.9	5.9	243.8	16.9	5.9
% Gravel	**0.0**	**0.1**	**0.8**	**0.4**	**0.1**	**32**	**0.0**	**0.3**
% Sand	**5.1**	**4.0**	**25.5**	**5.1**	**4.6**	**38**	**12.9**	**4.1**
% Silt & Clay	**94.9**	**95.9**	**73.6**	**94.5**	**95.3**	**30**	**87.1**	**95.6**

Remarks: As an added benefit to our clients, and whenever possible, the mass and percent gravel is included in this report in order to aid in proper soil classification. Any gravel is always included in the percent retained on the #200 sieve even if it is not weighed separately to determine the percentage.

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Mottled Brown Lean CLAY	41	24	17		95.3	CL
■	Grayish Brown Silty SAND w/ Gravel	16	14	2		30.4	SM
▲	Gray Silty SAND w/ Gravel	NP	NP	NP	71.5	37.8	SM
◆	Mottled Brown & Gray Lean CLAY	37	21	16		87.1	CL

Project No. 045-009 **Client:** Stantec

Project: Tulalip Battle Creek - 224202267

●**Source of Sample:** B-2 **Depth:** 5 **Sample Number:** B-2 5.0'

■**Source of Sample:** B-2 **Depth:** 10 **Sample Number:** B-2 10.0'

▲**Source of Sample:** B-2 **Depth:** 20 **Sample Number:** B-2 20.0'

◆**Source of Sample:** B-5 **Depth:** 5 **Sample Number:** B-5

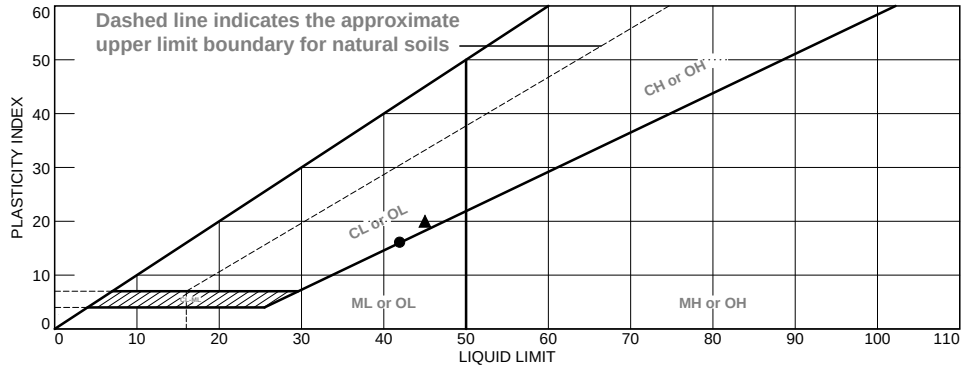
Remarks:

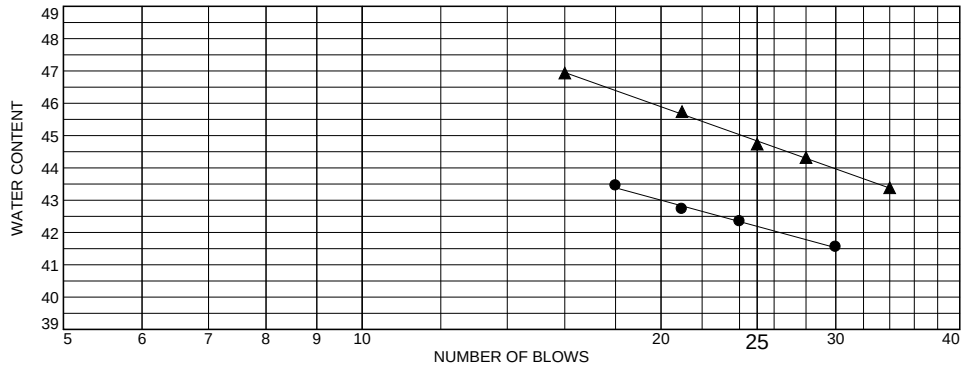
▲Non-Plastic, slides in bowl.

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Figure

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Grayish Brown Lean CLAY	42	26	16		95.6	CL
■	Gray Silty SAND	NP	NP	NP		42.7	SM
▲	Pale Brown Lean CLAY	45	25	20		94.5	CL

Project No. 045-009 **Client:** Stantec

Project: Tulalip Battle Creek - 224202267

●**Source of Sample:** B-6 **Depth:** 5 **Sample Number:** B-6 5.0'

■**Source of Sample:** B-6 **Depth:** 25 **Sample Number:** B-6 25.0'

▲**Source of Sample:** B-7 **Depth:** 5 **Sample Number:** B-7 5.0'

Remarks:

■Non-plastic, slides in bowl.

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Figure

BENCHMARK GEOLABS

Specific Gravity by Pycnometer
ASTM D 854

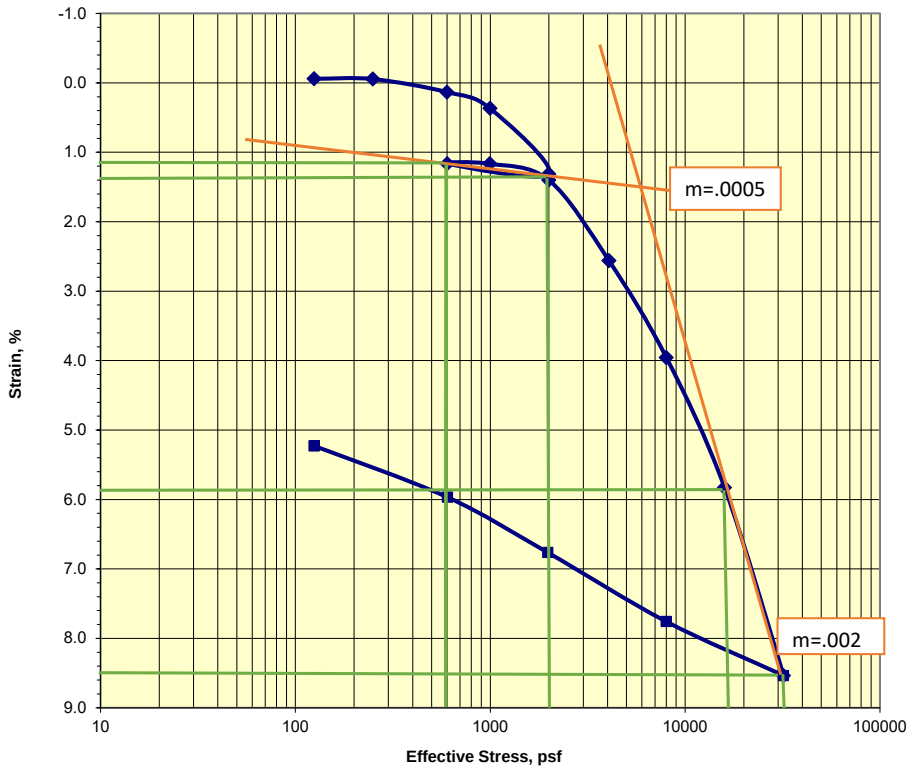
BGL Job#:	045-009		**Project Name:**	Tulalip Battle Creek		**Date:**	10/29/20	
Client:	Stantec		**Project No.:**	224202267		**Run By:**	PJ	
						Checked	PJ	
Boring:	B-2	B-3	B-7					
Sample:	Shelby Tube	-	B-7 10.0'					
Depth, ft.:	10	-	10					
Pan No.:								
Soil Description (visual)	Mottled Gray CLAY	Pale Brown CLAY	Mottled Gray CLAY w/ Sand					
Pycnometer ID:	P5	P3	P8					
Mass of Clean, Dry Pycnometer (g):	81.85	92.55	107.58					
Mass of Pycnometer, Soil, and Water (g):	355.83	365.95	381.91					
Temperature of Slurry (°C):	21.0	20.9	20.9					
Tare ID:								
Mass of Tare (g):	302.55	292.02	306.15					
Mass of Dry Soil and Tare (g):	341.23	329.97	345.83					
Mass of Dry Soil (g):	38.68	37.95	39.68					
Mass of Pycnometer and Water at Test Temp (g):	331.15	341.81	356.51					
Specific Gravity @ Test Temp:	2.763	2.749	2.779					
Specific Gravity @ 20 °C:	**2.763**	**2.748**	**2.779**					

BENCHMARK GEOLABS

Consolidation Test
ASTM D2435

BGL No.:	045-009	**Boring:**	B-3	**Run By:**	PJ
Client:	Stantec	**Sample:**	-	**Checked:**	PJ
Project:	Tulalip Battle Creek	**Depth, ft.:**	-	**Date:**	10/30/2020
Project No.	224202267	**Soil Type:**	Pale Brown CLAY		

Strain-Log-P Curve



Measured Gs 2.748	Initial	Final
Moisture %:	27.3	28.1
Dry Density, pcf:	91.7	96.7
Void Ratio:	0.872	0.774
% Saturation:	86.2	99.8

Remarks: This sample exhibited a tendency to swell.

BENCHMARK GEOLABS

Corrosivity Tests Summary

BGL # 045-009 Date: 10/29/2020 Tested By: PJ Checked: PJ

Client: Stantec Project: Tulalip Battle Creek Proj. No: 224202267

Remarks: The pH on sample B-1 15.0' was variable.

Sample Location or ID			Resistivity @ 15.5 °C (Ohm-cm)			Chloride	Sulfate		pH	ORP (Redox)		Sulfide	Moisture	Soil Visual Description
			As Rec.	Min	Sat.	mg/kg	mg/kg	%		E_H (mv)	At Test	Qualitative by Lead	At Test %	
						Dry Wt.	Dry Wt.	Dry Wt.						
Boring	Sample, No.	Depth, ft.	ASTM G57	Cal 643	ASTM G57	EPA 300.0	EPA 300.0	EPA 300.0	ASTM G51	ASTM G200	Temp °C	Acetate Paper	ASTM D2216	
B-7	B-7 5.0'	5	-	-	3,129	<2	<2	<0.0002	6.8	-	-	-	26.6	Pale Brown Lean CLAY
B-7	B-7 15.0'	15	-	-	8,366	<2	<2	<0.0002	7.3	-	-	-	15.3	Gray Lean CLAY