BIA - Bannock Pumping Plant Modernization

OWNER

BUREAU OF INDIAN AFFAIRS/FORT HALL IRRIGATION PROJECT
MAILING ADDRESS:
P.O. BOX 220
FORT HALL, ID 83203
PHYSICAL ADDRESS:
36 BANNOCK AVENUE
FORT HALL, ID 83203

ENGINEER

HDR ENGINEERING, INC.
ATTN: JERRY OTTO, P.E.
412 E PARKCENTER BLVD., SUITE 100
BOISE, ID 83706
PHONE: 208-387-7100
EMAIL: JERRY.OTTO@HDRINC.COM
WEBSITE: HTTPS://WWW.HDRINC.COM

Construction Documents
Project Manual

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HDR Project No. 10334741

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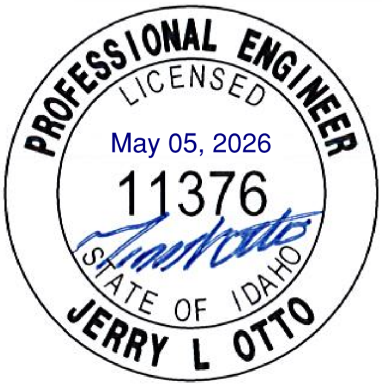
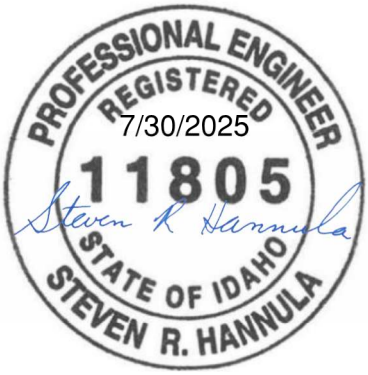
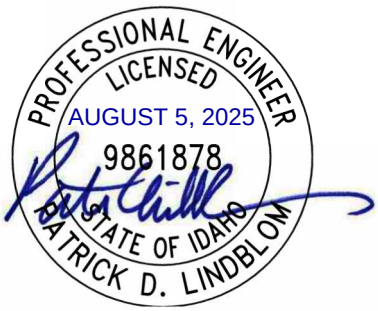
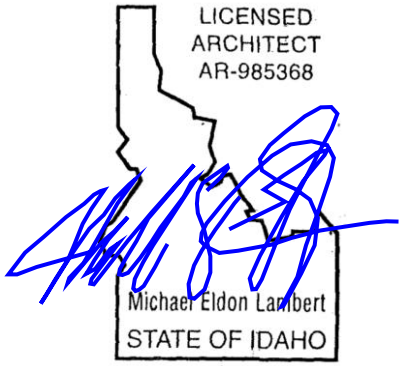
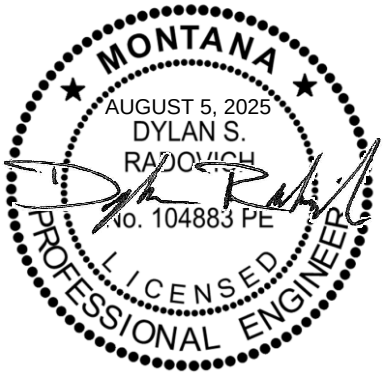
Seals and Signatures

Owner Name: U.S. Department of the Interior, Bureau of Indian Affairs
Facility or Site Name: Fort Hall Irrigation Project
Project Name: Bannock Pumping Plant Modernization
Project or Contract Designation: 140A1622F0026
Engineer: HDR

Jerry L. Otto, PE License No. 11376  	• The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Overall Project • Division 01 • Division 02 • Division 46 • Section 06 82 00 • Section 10 14 00
Steve Hannula, PE License No. 11805  	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Sections 40 05 00, 40 05 07, 40 05 24, 40 05 51, 40 05 52, 40 05 57, 40 05 61, 40 05 63, 40 05 64, 40 05 66. • Division 22

Patrick Lindblom, PE License No. 9861878 	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Division 03 • Division 04 • Division 05
William Rebik, PE License No. 81893 	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Division 31 • Division 32
Kent Cheung, PE License No. M32536 	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Division 23 • Section 40 42 00

Michael Lambert, RA License No. AR-985368  Signed 07 31 2025	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Division 07 • Division 08 • Division 09 • Section 06 10 00 • Section 10 44 33 • Section 10 14 23
Ginette Chin, PE License No. 37022 05 AUGUST 2025	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • Division 26
Dylan Radovich, PE License No. 104883  	The seal and signature to the left applies to the following Specifications divisions and sections of this project manual: • 40 61 13 • 40 61 93 • 40 61 96 • 40 63 43 • 40 66 40 • 40 67 00 • 40 71 00 • 40 72 00 • 40 73 00 • 40 74 00 • 40 78 00

Engineer's seal and signature does not apply to the documents that comprise Division 00, Bidding and Contracting Requirements.

It is a violation of applicable laws and regulations governing professional licensing and registration for any person, unless acting under the direction of the licensed and registered design professional(s) indicated above, to alter in any way the Specifications in this project manual.

END OF SEALS AND SIGNATURES

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DIVISION 01

GENERAL REQUIREMENTS

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SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Location and description of Work and prior uses of the Site.
2. Construction Contracts for this Project.
3. Others retained by Owner for the Project.
4. Work by others not under Owner's control.
5. Work by Owner.
6. Sequence and progress of Work.
7. Contractor's use of the Site.
8. Easements and rights-of-way.
9. Partial utilization by Owner.
10. Utility owners.
11. Fences

B. Related Requirements:

1. Include, but are not limited to, the following:
   a. Section 01 14 16 - Coordination with Owner's Operations.
   b. Section 01 45 33 - Code-Required Special Inspections and Procedures.

1.2 LOCATION AND DESCRIPTION OF WORK

A. The Project includes constructing the Work broadly described below, in accordance with the Contract Documents, with all related appurtenances. The established building code governing the design and construction is NFPA 5000. Work shown on the Drawings, or indicated in the Specifications, or indicated elsewhere in the Contract Documents is part of the Work, regardless of whether indicated below.

1. Civil Upgrades:
   a. Install slab-on-grade concrete debris management area at the traveling screen site.
   b. Replace existing steel catwalk crossing Bannock Creek adjacent to the traveling screen with a new fiberglass reinforced plastic pedestrian bridge.
   c. Install 8-ft high security fence and gates around pumping plant facility.
   d. Replace existing steel trash racks on pumping plant forebay.
   e. Install Foundation Drain around new electrical building, transformer and HVAC concrete pads.
   f. Install all-weather gravel surface at pumping plant facility and regrade site to drain.
   g. Install traffic bollards to protect new propane tank, electrical building HVAC unit, electrical transformer and new expanded pumping plant valve vault.
   h. Add new sidewalks, stairs, ladders, landings and railing at pumping plant.
2. Architectural Improvements:
   a. Replace existing forebay ladders with OSHA compliant ladders.
   b. Replace existing pumping plant roof with standing seam metal roof.
   c. Install fall protection at pumping plant forebay debris management area and on the pumping plant roof.
   d. Replace exterior windows on the west side of the pumping plant.

e. Replace existing roll-up door in the pumping plant.
f. Remove existing windows on the east side of the pumping plant and finish/frame opening.
g. Replace open steel grating with solid removable floor system.
h. Clean surfaces and construct cosmetic repairs to the existing concrete and concrete masonry inside and outside of the pumping plant.
i. Repaint the interior and exterior of the pumping plant where indicated.
j. Seal existing concrete interior floor.

3. Pumping System Upgrades:
   a. Replace all pumps, motors, valves and other appurtenances supporting the pumping system to achieve efficiency and reliability goals.
   b. Low-Lift Pumps: Vertical Turbine, 1-Stage, 26.0 cubic feet per second (cfs), 350 horsepower (hp), Rated Head: 97 feet.
   c. High-Lift Pumps: Vertical Turbine, 3-Stage, 13 cfs. 350 hp, Rated Head: 197 feet.
   d. Replace valves and other appurtenances within expanded vault. Expand vault to accommodate electromagnetic flow meters and other components for the low-lift pumping system. Rehabilitate new flap gates within the low-lift tower. The table below summarizes the proposed pumping system mechanical valving improvements.

Item	Low-Lift Quantity	High-Lift Quantity
20-inch Flow Meter	3	0
18-inch Flow Meter	0	3
18-inch Resilient Hinge Check Valve	0	3
18-inch manually operated double eccentric butterfly valve	0	3
Rehabilitate 36-inch Flap Gates	3	0
3-inch drain system	0	3

   e. Install centralized lubricant oil station to include a single location for the oil drum with a wall mounted air-operated oil transfer pump with a distribution line to each oil reservoir at each pump.
   f. Replace high-lift system air-vacuum valve and other high-lift surge protection appurtenances as shown on the contract drawings.
4. Mechanical Upgrades:
   a. Install heating, ventilation and air-conditioning system in new electrical building.
   b. Install new forced ventilation system in pumping plant.
   c. Install new compressed air supply in pumping plant.
   d. Replace existing traveling screen at main canal siphon.
5. Electrical Upgrades:
   a. Replace existing medium voltage electrical distribution system with 480-volt (V), three-phase system.
   b. Install Owner-furnished transformer.
   c. Construct a new electrical distribution building to house supervisory control and data acquisition (SCADA) system, controls, and new electrical equipment achieving modern electrical code and Occupational Safety and Health Administration (OSHA) safety standards.
   d. Install new 3000-amp service switchboard.
   e. Install new interior and site exterior pumping plant lighting along with security cameras.
   f. Install new electrical supply wiring, conduit, pole, lighting and camara at the traveling screen site.

g. Replace all wiring and conduits within pump station. Where lighting and receptacle conduit is routed in the concrete walls, existing conduit may be reused if suitable.
h. Incorporate an automatic transfer switch to provide for the standby generator sized to supply power to electrical building house load operations during power outages. No pumps are intended to operate via the standby generator.
i. Incorporate a manual transfer switch and exterior receptacle to allow connection of a portable standby generator sized in order to operate a single pump.
j. Install new electrical service sized for all six 350-hp pump motors.

6. Structural Upgrades
   a. Replace pumping plant bridge crane.
   b. Expand mechanical below-ground vault and construct new walls, roof system, roof access hatches, and personnel ladders and access catwalks.
   c. Expand existing traveling screen concrete structure to accommodate new traveling screen.
   d. Install new catwalk system at traveling screen.
   e. Construct foundation for new electrical building and associated concrete slabs for HVAC system and propane tank and concrete vault for new transformer.
7. SCADA/Telemetry Upgrades:
   a. Install control switches and human-machine interface (HMI) inside the new electrical (controls and switchgear) building and a secondary display with controls in the pumping plant.
   b. Integrate human interface modules (HIMs), indicating pilot lights, and other indicators on the doors of each motor controller for intuitive operation.
   c. Install master control panel (MCP) adjacent to the motor controllers and display systemwide statuses as applicable. When the system is in AUTO mode, all functions can be controlled from this location.
   d. Integrate automated operational alarm systems to immediately alert FHIP of operational issues.
   e. Install remote pressure transducer on high-lift pumping system and install remote water surface level transducer on the low-lift canal.
   f. Install low-level water surface sensors in pump station forebay.
8. All other Work required in accordance with the Contract Documents.

B. The Work is located on the Fort Hall Reservation in Power County, Idaho. See contract drawings for specific location. The pumping plant resides within the following Township and Range:

Section	S6 T7S R33E
Quarter	SE 1/4 of SW 1/4
Meridian	Boise
State	Idaho

C. Contracting Method: The Project will be constructed under a single prime construction Contract.

D. Hazardous Environmental Conditions:
   1. To the best of Owner's knowledge, information, and belief, the use of the Site in modern times has included only the irrigation infrastructure features. Existing buildings at the Site were constructed in1965.
   2. A Hazardous Environmental Condition, described in Section 02 26 00 – Hazard Materials Assessment, will (or has reasonable potential to) affect the Work.

1.3 CONSTRUCTION CONTRACTS FOR THIS PROJECT

A. Single Prime Construction Contract: The Contract requires all the Work for the Project not expressly allocated to Owner or others in the Contract Documents.

1.4 OTHERS RETAINED BY OWNER FOR THE PROJECT

A. Engineer:

1. Engineer is identified in the Agreement.
2. Engineer's responsibilities for the Project, relative to Contractor, are indicated throughout the Contract Documents.

1.5 WORK BY OTHERS NOT UNDER OWNER'S CONTROL

A. Work by Utility Owners and Transportation Facility Owners:

1. Owner is aware of the work indicated below, to be performed at or adjacent to the Site, by utility owners (not under Owner's control) or owners of transportation facilities (not under Owner's control).
2. Idaho Power replacement of existing 46kV transmission line with 12.5kV transmission line.
   a. Project location is in alignment with Ramsey Road to the pumping plant. Idaho Power will reuse the existing transmission pole on the north end of the existing substation to route power to the new electrical building. The timing of the project is unknown at this time but is expected to be before, based on the current construction schedule, switch over from medium to low voltage at the pumping plant.

1.6 WORK BY OWNER

A. Owner will perform the following in connection with the Work:

1. Operate all existing valves, flow-control gates, pumps, equipment, and appurtenances that will affect Owner's operations or facility processes, unless otherwise specified or indicated.

1.7 SEQUENCE AND PROGRESS OF WORK

A. Sequencing:

1. Incorporate sequencing of the Work into the Progress Schedule.

   Sequencing Requirements are provided in Section 01 14 16 – Coordination With Owner's Operations.

B. Requirements for sequencing and coordinating with Owner's operations, including maintenance of facility operations during construction, and requirements for tie-ins and shutdowns, are in Section 01 14 16 - Coordination with Owner's Operations.

1.8 CONTRACTOR'S USE OF SITE

A. Use of Site - General:

1. Relocate stored materials and equipment that interfere with operations of Owner, other contractors, and others performing work for Owner.

B. Owner will occupy the Site jointly with Contractor during construction for performance of Owner's typical operations. Coordinate with Owner in all construction operations to minimize conflicts between Contractor and Owner's employees and others under Owner's control. If the Site is a treatment facility or other production facility, Owner will have Owner's suppliers for deliveries of chemicals and other items accessing the Site from time to time, possibly on a daily basis.

1.9 EASEMENTS AND RIGHTS-OF-WAY

A. Easements and Rights-of-Way - General:

1. Easements and rights-of-way required for the permanent improvements included in the Work will be provided by Owner in accordance with the General Conditions and Supplementary Conditions.

2. Confine construction operations within Owner's property, public rights-of-way, easements obtained by Owner, and limits shown, and property for which Contractor has made arrangements directly with property owner(s).
3. Use care in placing construction tools, machinery and equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
4. Do not enter private property outside the construction limits without permission from the owner of the property.

B. On Private Property:

1. General limits of Owner-furnished easements are shown on the Drawings.

1.10 PARTIAL UTILIZATION BY OWNER

A. Prior to Substantial Completion of the entire Work under the Contract, substantially complete the Work as indicated for Milestones as defined in Section 01 14 16 – Coordination with Owner's Operations, 1.6 Sequence of Work.

1.11 UTILITY OWNERS

A. Utilities known to Engineer and that may have Underground Facilities or other facilities in the vicinity of the Work are:

1. Idaho Power
   a. Above ground 46kV transmission line and pole
   b. Above ground station service line and pole.

B. Utilities and their owners indicated in the Contract Documents are for Contractor's convenience. Neither Owner nor Engineer will be liable to Contractor or any utility owner for failure to indicate utility, its owner, or complete and correct contact information in the Contract Documents where Contractor's reasonable and ordinarily-exercised diligence would reveal the presence of the utility and its owner. Nothing in the Contract mitigates Contractor's responsibilities under the General Conditions and Laws and Regulations, including "call before you dig" regulations.

1.12 FENCES

A. All fencing not required to be demolished Work shall be maintained by the Contractor until completion of the Work. Fences distributed by the construction shall be restored by the Contractor to their original or better condition and to their original location unless otherwise indicated.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 14 00
WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section covers the restrictions for sequencing the work and maintenance of irrigation water.

1.2 RELATED SECTIONS

A. The following list of related specification sections is not intended to be all inclusive.

1. Section 01 14 16 – Coordination with Owners Operations
2. Section 01 57 20 – Environmental Protection
3. Section 01 57 90 – Preservation of Archaeological Data

1.3 IRRIGATION REQUIREMENTS

A. The Owner, Fort Hall Irrigation Project (FHIP), Bannock Pumping Plant, provides its water users with irrigation water from approximately 15 April through 15 October annually. A stipulation of this Contract is that the south main irrigation canal, pumping plant and low and high-lift irrigation distribution system shall remain operational during irrigation season. FHIP typically operates 24-hours every day during irrigation season.

1.4 OWNERS REPRESENTATIONS

A. Typical Irrigation Schedule. FHIP schedules annual canal dry-up periods in the fall and winter months to facilitate project maintenance. Although the exact irrigation seasons vary from year to year, the typical schedule is:

1. The main canal is typically drawn down annually to a zero-flow rate beginning October 15th.
2. The main canal is typically annually filled beginning on April 15th.

B. Planned Irrigation Schedule

1. Dates have not been established for the construction period; however, the Contractor can expect the irrigation season to follow the typical schedule defined herein.
2. The Contractor shall verify with the FHIP regarding specific irrigation dates planned for draw downs and filling of the main canal.

C. Maximum Irrigation Flow Rates

1. FHIP reports that the existing main canal maximum flow is approximately 120 cubic feet per second (cfs).

1.5 SITE ACCESS

A. Provisions for site access are as defined in the Drawings.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 01 14 16
COORDINATION WITH OWNER'S OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for coordinating with Owner's operations during the Project.
2. Sequence of Work and Milestones
3. Requirements for tie-ins and shutdowns necessary to complete the Work without impact on Owner's operations except as allowed in this Specifications section.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with Owner's operations during the Work in accordance with this Specifications section.
2. Except for shutdowns specified in this Specifications section, perform the Work such that Owner's facilities remain in continuous, satisfactory operation during the Project. Schedule and perform the Work such that the Work does not: impede Owner's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, cause odors or other nuisances, does not affect the public health, safety, welfare, and convenience, and does not adversely affect the environment resulting in violation of Laws or Regulations.
3. Work not specifically addressed in this Specifications section or in referenced sections may, in general, be performed, to be completed within the Contract Times, at any time during regular working hours in accordance with the Contract Documents, subject to the requirements in this section.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 01 11 00 - Summary of Work.
2. Section 01 14 00 – Work Restrictions
3. Section 01 64 00 – Owner-Furnished Products
4. Section 01 73 29 - Cutting and Patching.
5. Section 01 75 00 - Checkout and Startup Procedures.
6. Section 02 41 00 - Demolition.

1.2 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Specifications section have the meaning indicated below:
   a. The term "Owner" is used throughout this section. When the facility is operated or managed by an entity other than Owner, references in this section to "Owner" as the operator or manager of the facility will be interpreted as referring to the facility manager.

b. A “shutdown” is when a portion of the normal operation of Owner’s facility, whether equipment, systems, conduit (including piping and ducting), has to be temporarily suspended or taken out of service to perform the Work.

c. A “tie-in” is a connection of new Work to existing facilities, including connecting to existing conduits (including piping and ducting), electrical systems, structural elements, process/mechanical elements, and other physical connections. Some tie-ins may require that the tie-in be made without an associated shutdown.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review construction procedures under other Specifications sections and coordinate Work that will be performed with or before the Work indicated in this Section.
2. Notify other contractors in advance of Work requiring coordination with Owner’s operations, to provide other contractors sufficient time for work included in their contracts that will be performed with or before Work indicated in this section.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Shutdown Planning Submittal:
   a. For each shutdown, submit an inventory of labor, materials, and equipment required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for Owner to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.
   b. Furnish submittal to Engineer not less than 30 days prior to proposed shutdown start date. Do not start shutdown until obtaining Engineer’s acceptance of shutdown planning Submittal.
2. Shutdown Notification:
   a. After Engineer’s acceptance of shutdown planning Submittal and prior to starting the shutdown, submit written notification to Owner and Engineer of date and time each shutdown is to start. Submit notification not less than 72 hours in advance of each shutdown.

1.5 GENERAL CONSTRAINTS

A. Indicated in the Contract Documents are the annual irrigation shutdown durations.

B. The following constraints apply to coordination with Owner’s operations:

1. Operational Access: Owner’s personnel shall have access to equipment and areas of the facility that are required for operation.
2. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated, and ventilated spaces in areas of the facility that are adjacent to the Work and that must be kept operational.
3. Schedule and perform equipment and system start-ups in accordance with Section 01 75 00 - Checkout and Startup procedures. Equipment and systems shall not be placed into operation on Friday, Saturday, Sunday, or holidays without prior approval of Owner, unless specifically indicated otherwise in the Contract Documents.

1.6 SEQUENCE OF WORK

A. Perform the Work in the indicated sequence. Certain phases or stages of the Work may require working 24-hour days or work during hours outside of regular working hours. Work may be accelerated from a later stage to an earlier stage if Owner's operations are not adversely affected by proposed substitute sequence, with Engineer's approval. Stages specified in this article are sequence-dependent.

B. Pumping Plant.

1. Construction Stage 1 and **Milestone 1 – Procure Pumping Plant and Electrical equipment & materials, construct electrical building and install electrical equipment and controls: September 1, 2028.**

a. Procure required equipment and materials to fully construct the new electrical building and pumping plant upgrades including master control panel, service switchboard, variable frequency drives, SCADA, pumps, valves, etc.

b. Construct transformer vault. **Milestone 1A – Complete transformer vault, relocate and place Owner-furnished transformer on vault. See Section 01 64 00 – Owner-furnished Equipment for Owner-furnished transformer location and Vault foundation protection requirments: February 19, 2027.**

c. Construct remaining electrical building structure and architectural features and supporting infrastructure concrete slabs and conduits.

d. Construct upgrades to the pumping plant that can be accomplished without disruption to its operations during irrigation season to include installing new improvements to the low and high lift irrigation distribution system, architectural and safety upgrades, grading and drainage, rail crane upgrades, prework on the expanded valve vault, new trash racks, etc.

e. Install all new electrical building equipment and Owner provided transformer such that the electrical building is fully functional and ready for the new 12.5kV power supply connection and connection to the pump station.

2. Construction Stage 2 – Construct Pumping Plant Improvements:

Note: Replacement of pumps, pumps motors, electrical, controls valves and all other supporting equipment required to support a complete and functional pumping operation shall be installed and tested during a single non-irrigation season.

a. With all required equipment and materials procured, accepted and required to provide a fully functional pumping system, construct replacement of electrical, communications, pumping and valve system within the pumping plant. Conduct start-up and testing procedures.

3. Milestone 2 – Initiate Pump Demonstration Period: March 1, 2029.

4. Milestone 3 – Pumping Plant Substantial Completion: March 15, 2029

5. Construction Stage 3 – Complete Pumping Plant Improvements:

a. Complete all remaining pumping plant architectural, safety and civil improvements. Initiate and complete closeout.

6. Milestone 4 – Pumping Plant Final Completion: June 15, 2029

C. Traveling Screen.

1. Construction Stage 1 – Procure Traveling Screen and Pedestrian Bridge equipment and materials.

a. Procure and receive all required equipment and materials to provide a complete and operational Traveling Screen and new pedestrian bridge.

2. Construction Stage 2 – Construct Traveling Screen and associated concrete support structure improvements.
3. Construction Stage 3 – Initiate and complete traveling screen testing and start up.
4. **Milestone 5 – Traveling Screen Substantial Completion: March 15, 2028.**
5. Construction Stage 4 – Complete remaining traveling screen civil and safety improvements including pedestrian bridge.
6. **Milestone 6 – Traveling Screen and Site Improvements Final Completion: April 14, 2028.**

Note: Demolition and construction of new Traveling Screen shall occur in a single non-irrigation season.

1.7 TIE-INS

A. Table 01 14 16-A in this Specifications section lists connections by Contractor to existing facilities. Table 01 14 16-A may not indicate all tie-ins required for the Work; Contractor shall perform tie-ins necessary and required to complete the Work as shown or indicated in the Contract Documents, regardless of whether tie-in is indicated in Table 01 14 16-A. For tie-ins not indicated in Table 01 14 16-A, obtain requirements for tie-ins from Engineer by requesting an interpretation or clarification.

1.8 SHUTDOWNS

A. No shutdowns during irrigation season will be allowed unless coordinated and approved by the Owner.

B. Work that may interrupt normal operations shall be accomplished at times convenient to Owner unless otherwise indicated in the Contract Documents.

C. If Contractor's operations cause an unscheduled interruption of Owner's operations, immediately re-establish satisfactory operation for Owner.

D. Fines and Penalties Imposed by Authorities Having Jurisdiction:

1. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of Owner's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by Contractor if, in Engineer's opinion, Contractor did not comply with requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in performing the Work and complying with applicable permits, Laws, and Regulations.
2. Owner or Engineer may deduct as set-offs such amounts from payments due Contractor.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 SUBSTITUTE PROCEDURES

A. Proposal of Substitute Sequencing, Shutdowns, and Tie-Ins:

1. As a substitute to the procedures indicated in this Specifications section, Contractor may propose providing additional temporary facilities that can eliminate or mitigate a constraint without additional cost to Owner, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect Owner's ability to comply with Laws and Regulations, permits, and operating requirements;

that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.

2. Engineer will consider proposals for substitute procedures after the Effective Date of the Contract. All Bids shall be based on the requirements of the Contract Documents, including this section.
3. Substitution Requests:
   a. When proposing a substitute procedure for a tie-in or shutdown or other requirements of this section, comply with the requirements of the General Conditions and Supplementary Conditions (regarding substitutes) and Section 01 25 00 - Substitution Procedures.
   b. When deviation from specified sequence or procedures is proposed, Contractor's proposal shall explain in detail the proposed sequence and procedures and associated effects, including evidence that Owner's operations will not be adversely affected, to an extent greater than originally contemplated in the Contract Documents, by proposed substitution. List benefits of proposed substitution, including benefits to Progress Schedule.

3.2 GENERAL PROVISIONS FOR COORDINATING WITH OWNER'S OPERATIONS

A. When possible, combine multiple tie-ins into a single shutdown to reduce impacts on Owner's operations and processes.

B. Operation of Existing Systems and Equipment during the Work:

1. Do not shut off or disconnect existing operating systems or equipment, unless accepted by Engineer in writing.
2. Operation of existing systems and equipment will be by Owner unless otherwise specified or indicated.
3. Where necessary for the Work, Contractor shall seal or bulkhead Owner-operated gates and valves to prevent leakage that may affect the Work, Owner's operations, or both.
4. Provide temporary watertight plugs, bulkheads, and line stops as necessary and as required. After completing the Work, remove seals, plugs, bulkhead, and line stops to satisfaction of Engineer.

C. Performing the Work of this section constitutes Contractor's approval of underlying work and field conditions prevailing at the time of the Work.

3.3 PREPARATION

A. Coordinate preparations for removals with requirements of Section 01 73 29 - Cutting and Patching and Section 02 41 00 - Demolition, as applicable.

B. Shutdowns - General Preparation:

1. Coordinate shutdowns with Owner and Engineer.
2. Submit shutdown planning Submittals and shutdown notification Submittals in accordance with this Specifications section's "Submittals" Article.
3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with such requirements before commencing the shutdown.

4. Engineer shall have no duty to Contractor to advise Contractor of inadequate preparations by Contractor; Contractor is solely responsible for the means, methods, procedures, techniques, and sequences of construction.

C. Shutdowns of Electrical Systems:

1. Comply with Laws and Regulations, including the National Electric Code.
2. Contractor shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cables and wires are de-energized to ground potential before starting other Work associated with the shutdown.
3. Upon completion of shutdown Work, remove the locks and tags and advise Engineer or Resident Project Representative (RPR) that facilities are available for use.

3.4 ATTACHMENTS

A. The following, bound after this Specifications Section's "End of Section" designation, are part of this Specifications Section:

1. Tables:
   a. Table 01 14 16-A, Schedule of Tie-ins (1 pages).

END OF SECTION

Table 01 14 16-A Schedule of Tie-Ins					
Tie-In No.	**New Line Size and Service**	**Existing (Connecting) Line Size & Service**	**Tie-In Building/Location**	**Construction Stage**	**Remarks**
1	20-inch-diameter Steel Conveyance Pipe – Low Lift System (Quantity – 3)	20-inch-diameter Steel Pipe	Low lift vault	Stage II (Pumping Plant)	
2	20-inch-diameter Steel Conveyance Pipe – High Lift System (Quantity – 3)	20-inch-diameter Steel Pipe	High lift vault	Stage II (Pumping Plant)	
3	Idaho Power 12.5kV Connection to 4-inch conduit stub for new substation transformer	46kV Transmission connection to existing transformer – Idaho Power to disconnect	New substation transformer 4-inch stub	Stage II (Pumping Plant)	Contractor to provide new service pad and 4-inch stub. Idaho Power to provide conduit, wire and labor from pole to stub. Owner to supply transformer
4					
5					
6					

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SECTION 01 22 00
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements applicable to all bid/pay items.
2. General provisions on lump sums.

B. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 29 73 - Schedule of Values.
2. Section 01 29 76 - Progress Payment Procedures.

1.2 REQUIREMENTS APPLICABLE TO ALL BID/PAY ITEMS

A. In this Section and elsewhere in the Contract Documents, the terms “contract line item”, “CLIN”, “bid item”, “pay item”, “bid/pay item”, “Item” followed by a number designation, “this item”, and the like all have the same meaning, and refer to one or more specific elements of the Contract, established for pricing and payment, as indicated in the Bid Form and in the Agreement (or exhibit to the Agreement) at the time the Contract was signed by the parties.

1.3 GENERAL PROVISIONS ON LUMP SUM ITEMS

A. Progress payments will be based on an estimate of the accepted work performed through the end of the associated pay period, based on the Schedule of Values accepted by the Government.

1.4 BID/PAY ITEMS – BASE BID

A. Item 1 - Mobilization and Demobilization:

1. Item Includes:
   a. Work and activities indicated in this provision are intended as illustrative for purposes of scope and payment and do not represent a complete list of all preconstruction activities and Submittals, or all Work or activities required by the contract for mobilization and demobilization for work not including Traveling Screen.
   b. Mobilization Work paid under this item will include:
      1) Furnishing required performance bond and payment bond.
      2) Furnishing required insurance and associated documentation.
      3) Obtaining Owner’s acceptance of proposed Subcontractors and Suppliers and entering into subcontracts and purchase orders needed to start the Work.
      4) Preparing and obtaining Contracting Officer’s Representative approval of Shop Drawings.
      5) Preparing and obtaining Contracting Officer’s Representative acceptance of schedules, including Progress Schedule, Schedule of Submittals, and Schedule of Values.
      6) Preconstruction conference(s) required by the Contract Documents.
      7) Preconstruction photographic documentation.
      8) Establishing Contractor’s Site-specific health and safety plan, preconstruction activities needed to start implementing Contractor’s safety programs, and verifying status of training of construction workers and personnel and condition of construction equipment, machinery, and tools.
      9) Submitting acceptable emergency contact information
      10) Obtaining required permits needed to start the Work.

11) Initial establishment of temporary utilities and temporary facilities.
12) Establishing Contractor's field office and sheds, Contracting Officer's Representative's field office, Contractor's storage areas, staging and laydown areas, and other areas necessary to perform the Work.
13) Initial establishment of construction vehicular access to the Site, parking needed for construction, and offsite haul routes.
14) Establishing construction equipment, machinery, and tools at the Site.
15) Providing initial temporary controls.
16) Temporary security needed to start Work at the Site.
17) Other mobilization acceptable to Contracting Officer's Representative.

c. Demobilization Work paid under this item will include:
1) Removal from the Site and adjacent areas of excess materials and equipment.
2) Removal of temporary controls, temporary facilities, temporary barriers, and similar materials and equipment.
3) Removal of temporary access roads and parking areas not part of permanent pavement or otherwise allowed to remain by Owner, including temporary traffic controls established for construction vehicles and equipment.
4) Removal of all field office and sheds, storage areas, staging and laydown areas, and other areas needed to perform the Work and restoration of such areas.
5) Removal from the Site of all construction equipment, machinery, tools, Contractor's containers, temporary fuel storage tanks, and similar items.
6) Closeout of permits on which Contractor is a permittee or co-permittee.
7) Final cleaning.
8) Furnishing required closeout documents.
9) Other costs and effort by Contractor for demobilization.

d. Other cost and Work are under other bid/pay items in the Contract.

2. Payment: Partial payments shall be paid as follows:
a. 75% of the lump sum price following Contractor mobilization to the site.
b. 25% of the lump sum price for demobilization costs.

B. Item 2 – Pumping Plant:
1. Measurement: In accordance with the Schedule of Values..
2. Item Includes:
a. Site clearing, demolition, civil, electrical, controls, mechanical, process mechanical, architectural and structural improvements associated with the Pumping Plant site to include, but not limited to; the new electrical building and associated generator enclosure and slab, propane generator, above ground propane storage tank and concrete slab and transformer vault construction.
b. Improvements to both the high and low lift irrigation distribution systems.
c. Testing, startup and final acceptance of a complete and operational pumping plant.
d. Item 002 is associated with Project Classified System (PCS) 1 – Pumping Plant as described in Section 01 75 00 – Checkout and Startup procedures.
e. Maintenance and recording information of Project Record Documents in accordance with Section 01 78 39.
f. Payment of all federal, state, and local taxes including TERO taxes assessed by the Shoshone-Bannock Tribes. See https://www.sbtribes.com/tero/ for more information.
g. Payment under this line item will include all required work and costs not included in other base bid line items, even if work is not explicitly listed above.

1.5 BID/PAY ITEMS – OPTION

A. Option Item 3 - Mobilization and Demobilization for Traveling Screen:

1. Item Includes:

   a. Work and activities indicated in this provision are intended as illustrative for purposes of scope and payment and do not represent a complete list of all preconstruction activities and Submittals, or all Work or activities required by the contract for mobilization and demobilization of Traveling Screen.

   b. Mobilization Work paid under this item will include:

      1) Furnishing required performance bond and payment bond.
      2) Furnishing required insurance and associated documentation.
      3) Obtaining Owner's acceptance of proposed Subcontractors and Suppliers and entering into subcontracts and purchase orders needed to start the Work.
      4) Preparing and obtaining Contracting Officer's Representative approval of Shop Drawings.
      5) Preparing and obtaining Contracting Officer's Representative's acceptance of schedules, including Progress Schedule, Schedule of Submittals, and Schedule of Values.
      6) Preconstruction conference(s) required by the Contract Documents.
      7) Preconstruction photographic documentation.
      8) Establishing Contractor's Site-specific health and safety plan, preconstruction activities needed to start implementing Contractor's safety programs, and verifying status of training of construction workers and personnel and condition of construction equipment, machinery, and tools.
      9) Submitting acceptable emergency contact information
      10) Obtaining required permits needed to start the Work.
      11) Initial establishment of temporary utilities and temporary facilities.
      12) Establishing Contractor's field office and sheds, Contractor's storage areas, staging and laydown areas, and other areas necessary to perform the Work.
      13) Initial establishment of construction vehicular access to the Site, parking needed for construction, and offsite haul routes.
      14) Establishing construction equipment, machinery, and tools at the Site.
      15) Providing initial temporary controls.
      16) Temporary security needed to start Work at the Site.
      17) Other mobilization acceptable to the Contracting Officer's Representative.

   c. Demobilization Work paid under this item will include:

      1) Removal from the Site and adjacent areas of excess materials and equipment.
      2) Removal of temporary controls, temporary facilities, temporary barriers, and similar materials and equipment.
      3) Removal of temporary access roads and parking areas not part of permanent pavement or otherwise allowed to remain by Owner, including temporary traffic controls established for construction vehicles and equipment.
      4) Removal of all field office and sheds, storage areas, staging and laydown areas, and other areas needed to perform the Work and restoration of such areas.
      5) Removal from the Site of all construction equipment, machinery, tools, Contractor's containers, temporary fuel storage tanks, and similar items.
      6) Closeout of permits on which Contractor is a permittee or co-permittee.
      7) Final cleaning.
      8) Furnishing required closeout documents.
      9) Other costs and effort by Contractor for demobilization.

d. Other cost and Work are under other bid/pay items in the Contract.

2. Payment: Partial payments shall be paid as follows:
   a. 75% of the lump sum price following Contractor mobilization to the site..
   b. 25% of the lump sum price for demobilization costs.

B. Option Item 4 – Traveling Screen:

1. Measurement: In accordance with the Schedule of Values.
2. Item Includes:
   a. Site clearing, demolition, civil, electrical and structural and debris management area improvements, installation of new traveling screen and associated steel catwalk and railings, testing, startup and final acceptance of a complete and operational traveling screen.
   b. Site clearing, demolition, civil and structural foundation construction and installation of a new FRP pedestrian bridge.
   c. Item 102 is associated with Project Classified System (PCS) 2 – Traveling Screen as described in Section 01 75 00 – Checkout and Startup procedures.
   d. Maintenance and recording information of Project Record Documents related to Option Item 2- Traveling Screen in accordance with Section 01 78 39.
   e. Payment of all federal, state, and local taxes including TERO taxes assessed by the Shoshone-Bannock Tribes. See https://www.sbtribes.com/tero/ for more information.
   f. Payment under this line item will include all required work and costs for Traveling Screen not included in other option bid line items, even if work is not explicitly listed above.

END OF SECTION

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SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements applicable to all substitution requests.
2. Provisions specific to Contractor's substitution requests for:
   a. Materials and equipment to be incorporated into the Work.
   b. Methods, procedures, and sequences indicated in the Contract Documents.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals, and pay all costs associated with requests for approval of substitutes.
2. Where the Contract Documents expressly indicate that substitutes are not allowed, are unacceptable, or time-barred, do not submit substitution requests for such items or procedures.
3. Requirements for Contractor's proposal of "or-equals", where allowed by the Contract, are in Section 01 62 00 - Product Options.

C. Related Requirements:

1. Include, but are not necessarily limited to:
   a. Section 01 62 00 - Product Options.

1.2 REFERENCES

A. Terminology:

1. The following terminology, although not indicated with initial capital letters, has the following meaning in this Section:
   a. "Or-equal" and "or equal" each means material or equipment items to be incorporated into the completed Work as a functioning whole, or method, procedure, or sequence that, in Engineer's sole opinion, are equivalent to that shown or indicated in the Contract Documents.
   b. "Substitute" means a proposed materials or equipment to be incorporated into the completed Work as a functioning whole, or a proposed construction method, procedure, or sequence that is not, in Engineer's sole opinion, equivalent to the associated, similar material or equipment item or method, procedure, or sequence shown or indicated in the Contract Documents, but accomplishes the same or similar purpose. Unless expressly indicated otherwise in the Contract Documents, Contractor's proposals for "value engineering" (and similar terms) are substitutes.
   c. "Substitution request" means Contractor's written request for Engineer's approval of a proposed substitute, in accordance with this Section. Substitution requests are separate from Shop drawings and other Submittals required by the Contract Documents.

1.3 SUBSTITUTES - GENERAL

A. This Article applies to all substitutes and substitution requests, whether for substitute materials or equipment, or for substitute methods, procedures, or sequences.

B. This Section expands on the provisions on substitutes in the General Conditions, as may be modified by the Supplementary Conditions.

C. Time Limits for Submitting Substitution Requests:

1. Where the Contract allows Contractor's substitution requests, such proposals will be considered by Engineer only during a period of 60 days after the date the Contract Times start to run, unless otherwise indicated.
2. Substitution requests will be accepted for consideration by Engineer after the time limit indicated in the paragraph above this, when materials or equipment shown or indicated, and all associated "or-equals", are either:
   a. Unavailable; or
   b. Despite Contractor's due diligence, are unavailable in time for the Work to be completed within the Contract Times.
3. The foregoing notwithstanding, substitutes will not be approved when received by Engineer after Contractor has commenced the associated Work at the Site, where approval of the substitute would require rework or removing Work already installed.

D. Design Professional:

1. Engineer is responsible for design of the completed Project as a functioning whole and has responsible charge of the Project except for Work for which design responsibility is expressly delegated by the Contract Documents.
2. Do not retain services of any third-party design professional to prepare modifications of Engineer's design of the completed Project as a functioning whole without Engineer's express, written consent via an appropriate Contract modification setting forth appropriate performance and design criteria for delegating the design of the substitute.

E. Contractor's Representations:

1. In submitting each substitution request, Contractor represents that:
   a. Contractor has read and understands the Contract's provisions on substitutes, as indicated in the General Conditions, as may be modified by the Supplementary Conditions, this Section, and elsewhere in the Contract Documents.
   b. Substitution request is complete and includes all documents and information required by the Contract Documents.
   c. Contractor certifications required by the General Conditions, as may be modified by the Supplementary Conditions, and this Section are valid and made with Contractor's full knowledge, information, and belief.
   d. Contractor will provide the same or better guarantees and warranties for substitute as for the specified materials, equipment, methods, procedures, and sequences (as applicable).
   e. Contractor waives all rights for increasing the Contract Price or extending the Contract Times, related to the substitute, that subsequently may become apparent to Contractor after issuance of the associated Contract modification instrument approving such substitute, except for those associated with differing subsurface or physical conditions or discovery of a previously unforeseen Hazardous Environmental Condition associated with the Work involving the approved substitute.

F. Submittal of Substitution Requests - General:

1. Substitution requests must be submitted by Contractor. Engineer will not accept or review substitution requests from prospective or bona-fide Subcontractors or Suppliers.
2. Submit separate substitution request for each proposed substitute.
3. Submit substitution requests in accordance with requirements for Shop Drawings and other Submittals, as indicated in Section 01 33 00 - Submittal Procedures, and Section 01 31 26 - Electronic Communication Protocols.
4. Do not submit substitution requests as any of the following (such substitution requests will be returned by Engineer without review):
   a. Shop Drawing, Sample, or other Submittal.
   b. Request for approval of an “or-equal”.
   c. Request for interpretation (RFI) or clarification.
   d. Change Proposal without all other, required substitution request elements indicated below.
   e. Other oral or written communication not in accordance with this Section.
5. Each substitution request shall include:
   a. Transmittal letter (one per substitution request) expressly indicating the communication is a substitution request.
   b. Completed substitution request form, on the form attached to this Section.
   c. Change Proposal, submitted in accordance with the Contract Documents. Clearly indicate the proposed changes in Contract Price and Contract Times if substitute is approved; if none, clearly so indicate on the Change Proposal.
   d. Certifications and written representations required by the Contract Documents to accompany substitution requests.
   e. Other information: (1) required elsewhere in this Section and in other elements of the Contract Documents, and (2) deemed appropriate by Contractor to support Contractor’s substitution request.
6. When Engineer requires additional information to evaluate a substitution request, furnish such information within five days of receipt of Engineer’s request, unless additional time is granted by Engineer, in writing.
7. Engineer and Owner have the right to rely upon the completeness and accuracy of information, documents, certifications, and representations in Contractor’s substitution request. Contractor accepts full responsibility for completeness and accuracy of substitution requests (except for Engineer’s professional liability).

G. Engineer’s Review of Substitution Requests:

1. Engineer has no obligation to approve any substitute.
2. Substitutes will not be approved unless all of the following are satisfied for the associated substitute:
   a. The Contract supports submittal of such substitution request; and
   b. Substitute is reasonably consistent with Engineer’s design intent for the Project as a completed, functioning whole; and
   c. As indicated in Paragraph 1.3.A.3 of this Section.
   d. Substitute will not have an adverse effect on the work of other contractors, or existing or proposed construction; and
   e. Substitution request is complete in accordance with the Contract Documents and Engineer’s requests, and

f. Owner agrees to the substitute; and

g. Associated changes in Contract Price and Contract Times, if any, are acceptable to Owner.

3. Engineer is not obligated to approve any substitute where such approval is conditioned on an increase in the Contract Price, the Contract Times, or both.

4. Timeliness of Engineer's Review:

a. Allow not less than 14 days for Engineer's review of each substitute. Allow longer for larger, more-complex substitutes.

b. Engineer will endeavor to perform timely review of substitution requests. However, Contractor is responsible for complying with the Contract Times, regardless of whether the substitute is approved.

c. Where approval of a substitute would necessitate other changes to the Project's design, additional time, beyond that indicated above, will be necessary for Engineer's preparation of revisions to the design.

5. When Design Changes are Required with Approval of Substitute:

a. Engineer will advise Contractor promptly following Engineer's review (and Owner's comment, if any) on substitution request to indicate whether the substitute will be acceptable. Engineer's advisory to Contractor will indicate whether changes in Engineer's design are necessary and include a preliminary estimate of Engineer's fee and time required for modifying the design and preparing an associated Proposal Request to Contractor.

b. Engineer's preliminary estimates of fee and time for design modifications will be prepared in good faith, but are not binding on Owner or Engineer.

c. Contractor shall reimburse Owner for costs incurred by Owner for design modifications necessitated by approval of substitute. Owner may deduct such amounts, as one or more set-offs, from payments due Contractor under the Contract.

d. Upon Contractor's receipt of Engineer's estimate of fee and time for design modifications, contractor shall advise Engineer, in writing, within three days whether Contractor will continue pursing approval of the substitute.

e. Request to Contractor.

f. Engineer may reject a substitute that would require substantial changes in the Project's design.

H. Approval of Substitutes:

1. Substitutes are approved only via issuance of an appropriate Field Order or Change Order in accordance with .

2. Approval of a substitute does not relieve Contractor from obligation to comply with the Contract Documents, including submitting Shop Drawings, Samples, and other Submittals in accordance with the Contract Documents.

1.4 SUBSTITUTE MATERIALS AND EQUIPMENT

A. In addition to other requirements of this Section and elsewhere in the Contract Documents, substitution requests for substitute materials or equipment shall include:

1. Manufacturer and Location:

a. Name and address of manufacturer of the proposed substitute. Indicate country where manufacturer is incorporated and owned.

b. Companies and brands owned by or affiliated with manufacturer.

c. Name of manufacturers of principal component items, such as motors, bearings, and similar items.
d. Location where the items would be manufactured, including country and address. Indicate the total percentage of the items' value that will be manufactured outside of the United States and its territories.
e. Name, address, and driving distance from the Site of:
    1) Manufacturer's sales representative.
    2) Nearest service center offering full array of service capabilities.
    3) Warehouse or other location where spare parts for the proposed substitute are available.
f. Number of years that manufacturer has actively participated the North American market.

2. Proposed Materials and Equipment:
    a. Model designation and quantity of each proposed for the Work.
    b. Manufacturer's literature for proposed substitute, with description of the materials and equipment.
    c. Performance information and representative test data.
    d. Indication of reference standards with which materials and equipment comply.
    e. Preliminary process and instrumentation diagrams (P&ID), where applicable.
    f. Identification of hazardous materials, including Constituents of Concern, used in the materials and equipment, and associated permitting or licensing required.
    g. Manufacturer's standard warranty and applicable, proposed special or extended warranties, including indication of specific entities that will be beneficiary of such warranties.
    h. Complete list of proposed deviations from requirements of the Contract Documents.
    i. Itemized comparison of specified materials and equipment and proposed substitute, indicating:
        1) Size (physical dimensions) when: item is in use, when not in use, and space required for routine and major maintenance.
        2) Weight and loading at supports, when item is full and empty.

        Materials of construction.
3. Operation requirements, including:
    a. Anticipated consumption of each item of: Electricity, other energy sources, water, chemicals (indicate each), and other needs for operation at the Site.
    b. Typical labor required for operation and associated skill level.
    c. Description of remote monitoring and control capabilities, as applicable.
4. Maintenance requirements, including:
    a. Anticipated life in the service and environment required.
    b. Frequency and general scope of routine and major maintenance typically necessary.
    c. Typical labor requirements and general qualifications of personnel performing routine maintenance.
    d. Major, associated equipment necessary for routing and major maintenance, including hoisting equipment type and capacity (when applicable).
    e. Availability, scope, cost, and general conditions of service and maintenance contracts, if any.

5. References for similar projects on which the materials and equipment were used. Indicate for each:
    a. Project owner name, name of facility where installed, and name of project.
    b. City, state, and country of installation.
    c. Model number/size and quantity furnished and installed.
    d. Year of installation.
    e. Contact information for owner and design professional, including telephone numbers.
6. Other information required by the Contract Documents.
7. Other information reasonably requested by Engineer.

1.5 SUBSTITUTE CONSTRUCTION METHODS, PROCEDURES, OR SEQUENCES

A. Provisions of the General Conditions, as may be modified by the Supplementary Conditions, regarding substitutes of materials and equipment are hereby extended to apply to substitute methods, procedures, and sequences as shown or indicated in the Contract Documents.

B. In addition to other requirements of this Section and elsewhere in the Contract Documents, substitution requests for substitute methods, procedures, or sequences shall include:

1. Clear identification of the method, procedure, or sequence shown or indicated in the Contract Documents for which substitute is requested.
2. Detailed description of proposed substitute method, procedure, sequence, or combination thereof.
3. Reasons why substitute is proposed and benefits to the Project should the substitute be approved.
4. Detailed list of how the proposed substitute deviates from associated method, procedure, or sequence shown or indicated in the Contract Documents.
5. Impact of the substitute, if approved, on Owner's or facility manager's operations, when the Work is at an existing facility.
6. Effect on other contractors working at the Site, if substitute is approved.
7. Description of temporary equipment and temporary facilities needed, should the substitute be approved, including quantity of items, capacities, performance characteristics, permitting and approvals required by authorities having jurisdiction, and proposed location at the Site.
8. Written evaluation of how substitute method, procedure, or sequence complies with Laws and Regulations.
9. Drawings illustrating method, procedure, or sequence.
10. Materials to be used that contain Constituents of Concern or that have potential to cause or exacerbate a Hazardous Environmental Condition.
11. Other information and data required by the Contract Documents.
12. Other information reasonably required by Engineer.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The following, bound after this Section's "End of Section" designation, are part of this Specifications Section:

1. Exhibit A - Substitution Request Form (one page).

END OF SECTION

EXHIBIT A

Substitution Request Form

(One Item per each Form)

Project:	Date:	
Substitution Requestor:		
Contractor:		
Specification Section No:	Paragraph No. (i.e. 2.1.A.1.c):	Specified Item:
Proposed Substitution:		
Provide Product Data Sheets, Manufacturer's written installation instructions, drawings, diagrams, or any other information as an attached to this Form that will demonstrate the proposed substitution is an Approved Equal.		
State differences between proposed substitutions and specified item. Differences include but are not limited to interrelationship with other items; materials, equipment, function, utility, life cycle costs, applied finished, appearances, and quality. _____		
Document how the proposed substitution is compatible with or modifies other systems, parts, equipment or components of the Project and Work under the Contract _____		
Describe what effect the proposed substitution has on dimensions indicated on the Drawings and previously reviewed Shop Drawings? _____		
Describe what effect the proposed substitution has on the Construction Schedule and Contract Time. _____		
Describe what effect the proposed substitution has on the Contract Price. This includes all direct, indirect, impact and delay costs. _____		
Manufacturer's guarantees of the proposed and specified items are: ☐ Same ☐ Different (explain on attachment)		
The undersigned state that the function, utility, life cycle costs, applied finishes, appearance and quality of the proposed substitution are equal or superior to those of the specified item.		
For use by Engineer: ☐ Accepted – eligible for approval via Change Order ☐ Accepted as Noted – approval via Change Order ☐ Not Accepted _____ _____ *Date* *(Telephone)*: _____ Signature of PE, RA, or PG in Responsible Charge	_____ *(Contractor's Signature)* _____ *(Contractor's Firm)* _____ *(Firms Address)* _____ *(Telephone)*	

Comments:

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SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for the Schedule of values, including:
   a. Applicability.
   b. General provisions for Schedules of Values.
   c. Format, organization, and content of Schedule of Values.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 01 22 00 - Measurement and Payment.
2. Section 01 29 76 - Progress Payment Procedures.
3. Section 01 32 16 - Construction Progress Schedule.

1.2 PRICE AND PAYMENT PROCEDURES

A. Schedule of Values and Payment – General:

1. Contractor shall prepare and submit to Engineer for acceptance Schedule of Values that presents (as applicable): (a) an appropriate, detailed breakdown of the price of lump sum bid/pay items, and (b) an appropriate, detailed breakdown of the price of Work compensated on the basis of Cost of the Work plus a fee, and (c) lists bid/pay items of Unit Price Work. The total of all Work among the various bid/pay items shall equal the Contract Price.
2. For each item of lump sum Work and Work compensated on the basis of Cost of the Work plus a fee, the Schedule of Values shall, establish in detail the portion of the Contract Price allocated to each component of such Work.
3. Upon request of Engineer, promptly furnish data and information that substantiates and supports the amounts indicated in the Schedule of Values.
4. Submit preliminary Schedule of Values to Engineer for initial review. Contractor shall incorporate Engineer's comments into the Schedule of Values and resubmit to Engineer. Engineer may require corrections and re-submittals until Schedule of Values is acceptable.
5. Schedule of Values may be used, where appropriate, as a basis for negotiating price of changes, if any, in the Work.

B. Applicability:

1. Lump Sum Work:
   a. For Work paid on a lump sum basis, progress payments will be on the basis of Work performed in accordance with the Contract Documents, for each line item in the Schedule of Values, as recommended to Owner by Engineer.

1.3 ADMINISTRATIVE PROCEDURES

A. General Provisions for Schedules of Values:

1. This Section augments requirements for the Schedule of Values, indicated in the General Conditions, as may be augmented by the Supplementary Conditions.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Submit to Engineer the Schedule of Values in the form and quantity required in Section 01 33 00 – Submittal Procedures, and in accordance with Section 01 31 26 - Electronic Communication Protocols.
2. Content of Schedule of Values Submittals shall be in accordance with this Section.
3. Timing of Submittals:
   a. Preliminary Schedule of Values:
      1) Submit preliminary Schedule of Values within time limit indicated in the General Conditions.
   b. Initial Acceptable Schedule of Values:
      1) Revise the preliminary Schedule of Values in accordance with Engineer's comments.
      2) Contractor will not be eligible for progress payment until acceptable Schedule of Values is submitted in accordance with the Contract Documents.
      3) Submit the Schedule of Values acceptable to Engineer in accordance with the General Conditions.
   c. Updates: Submit updated Schedule of Values when:
      1) The Contract Price has changed.
      2) Requested by Engineer

1.5 FORMAT, ORGANIZATION, AND CONTENT OF SCHEDULE OF VALUES

A. Organization and Major Elements of Schedule of Values.
   1. Prepare Schedule of Values on the "progress estimate" or "continuation sheets", as applicable, of the Application for Payment form indicated in Section 01 29 76 - Progress Payment Procedures.
   2. Include in Schedule of Values itemized list of Work for each major work area included in the Work, for each lump sum payment item included in the Contract. Group the Work in the Schedule of Values into the following areas:
      a. Sitework and Facility Improvements, Pumping Station, Electrical Building, Electrical & Instrumentation, Traveling Screen.
         1) Contractor will not be eligible for progress payment until acceptable Schedule of Values is submitted in accordance with the Contract Documents.
   3. In addition, list either in the Schedule of Values or on a separate worksheet included with Applications for Payment all Unit Price Work bid/pay items in the Contract. The balance of this Article applies to lump sum Work.
   4. Organization in Accordance with Specification Sections:
      a. Within each work area, organize the Schedule of Values by the various Specifications section numbers and titles included in the Contract Documents.
      b. Label each row in the Schedule of Values with the appropriate Specifications section number. Include an amount for each row in the Schedule of Values.
      c. List sub-items of major materials, equipment, or systems, as appropriate or when requested by Engineer.

B. Requirements for both the preliminary Schedule of Values Submittal and the Schedule of Values Submittal for Engineer's acceptance are:
   1. Subcontracted Work:
      a. Schedule of Values shall indicate division of Work between Contractor and each Subcontractor.
      b. Line items for Work to be performed by each Subcontractor shall include the word, "(SUBCONTRACTED)" and the name of the Subcontractor once the associated subcontract is signed and effective.
   2. Apportionment between Materials and Equipment, and Installation: Schedule of Values shall include separate apportionment of costs for:

a. Cost of materials and equipment to be incorporated into the completed construction.
b. Cost of delivery, handling, and storage of materials and equipment to be incorporated into the completed construction.
c. Cost of temporary materials (such as excavation supports, scaffolding, and other temporary materials), and their associated delivery, handling, and storage costs, if any.
d. Cost of rentals of construction equipment and machinery, whether owned by Contractor or Subcontractor or leased from a third-party equipment rental entity.
e. Cost of installing materials and equipment.
f. Travel and subsistence costs, if any.
g. Other costs used in preparing the Bid by Contractor and each Subcontractor.

3. Sum of individual line item amounts indicated on the Schedule of Values shall equal the total of associated bid/pay item. Sum of bid/pay item totals in the Schedule of Values, plus the sum of any separate listing of Unit Price Work items, shall equal the total Contract Price.
4. Overhead and Profit:
   a. Include in each line item a directly proportional amount of Contractor's overhead and profit in the Contract Price.
   b. Do not include overhead and profit as separate line item(s).
5. Allowances: Include separate line item for each allowance.
6. Unit Price Work: Separately indicate items of Unit Price Work in the overall Schedule of Values. Where the required form (in accordance with Section 01 29 76 - Progress Payment Procedures) includes a separate worksheet or page for Unit Price Work, indicate all items of Unit Price Work on such worksheet or page of the form.
7. Bonds and Insurance Costs:
   a. Include line item for bonds and insurance in bid/pay item for actual costs incurred by the Contractor.
   b. Submit to Engineer and Owner documentation substantiating the actual costs.
   c. When Contractor has furnished performance and payment bonds and evidence of insurance acceptable to Owner and in accordance with the Contract Documents, entire amount for bonds and insurance may be applied for in the first Application for Payment.
8. Construction Support, Project Management, and Administrative Cost Elements:
   a. Costs under this category are sometimes informally referred to as "field overhead", but are Project costs rather than costs related to Contractor's general business operations.
   b. Include in the Schedule of Values relevant line items and amounts for work and services required by the General Conditions and specific Division 01 Specifications sections, such as:
      1) Project management costs.
      2) Onsite superintendence and supervision costs.
      3) Itemized list of Work by work area, as applicable, for costs associated with coordination with the Owner's operations, including required sequencing, as set forth in the Contract Documents.
      4) Updating the construction Progress Schedule, preparing time impact analyses, and preparing recovery schedules. Preparation of preliminary Progress Schedule and the initial ("baseline") Progress Schedule acceptable to Engineer are part of mobilization.
      5) Construction progress photographic documentation. Preconstruction photographic documentation and final photographic documentation are, respectively, part of mobilization and demobilization.
      6) Updates of the Schedule of Submittals.
      7) Contractor's safety representative and ongoing implementation of Contractor's Site-specific health and safety plan (SSHASP). Establishing the SSHASP is part of mobilization.

8) Ongoing compliance with permits (when applicable). Contractor's securing of required work permits is part of mobilization.
9) Ongoing cost for temporary utilities and temporary facilities. Establishing such services and facilities is part of mobilization.
10) Ongoing costs for temporary security .
11) Field offices (monthly rental and maintenance) and storage facilities (excluding costs of establishment and removal, which are part of mobilization and demobilization).
12) Ongoing site maintenance, such as temporary controls (dust, air pollution, water pollution, solid waste control, pest and rodent control, temporary erosion and sediment controls, and others), snow and ice removal, and similar activities.
13) Field engineering and surveying.
14) Progress cleaning and cleaning for Substantial Completion.
15) Record documents (preparation, maintenance, and submittal).
    a) If adequate record documents are maintained, up to 50 percent of the value of the record documents line item will be eligible for payment, spread evenly over those progress payments in which construction at the Site is performed.
    b) Remainder of Project record documents line item will be eligible for payment when complete record documents are submitted in accordance with the Contract Documents.
    c) If record documents submitted are unsatisfactory to Engineer, amount may be reduced via set-offs in accordance with the Contract Documents.
16) Other items required by Engineer.

c. Include such items in Applications for Payment on payment schedule acceptable to Engineer.
d. Such line items in the Schedule of Values shall exclude any and all costs associated with Contractor's permanent place(s) of business, personnel stationed at permanent office(s), salaries and bonuses of executive and administrative personnel not directly performing work on the Project, and general business expenses, all of which are part of Contractor's overhead costs.

9. Mobilization and Demobilization: Include all associated costs in the separate bid/pay item for mobilization and demobilization. The scope of such bid/pay item is indicated in Section 01 22 00 – Measurement and Payment.
10. Costs for Submittals, field quality control activities, and training of operations and maintenance personnel shall be as follows, unless otherwise accepted by Engineer:
    a. Submittals: Up to 8.0 percent of cost (including all associated overhead and profit) of each equipment item, exclusive of transportation and installation costs associated therewith, may be allocated to preparation of Shop Drawings, Samples ,and other Submittals required for release for purchase, fabrication, or delivery (as applicable) and may be included in the Application for Payment following Engineer's approval of Shop Drawings (and acceptance of other Submittals, as applicable) required for fabricating or purchasing for that item for the Work.
    b. Field Quality Control: Up to 3.0 percent of total cost of each item (including all associated overhead and profit), including materials and equipment, and installation, may be apportioned to specified or required field quality control activities (including required testing and inspections) and included in the Application for Payment following Engineer's acceptance of the associated written field quality control report Submittal(s).
    c. O&M Manual Submittals and Training: Up to a total of 4.0 percent of equipment cost (including all associated overhead and profit), exclusive of transportation and installation costs, may be apportioned to operations and maintenance manuals and training of operations and maintenance personnel, which may be included in the Application for Payment following completion of training for the associated item.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 29 76
PROGRESS PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for Contractor's progress payments.

B. Scope:

1. Contractor's requests for payment shall be in accordance with the Agreement, General Conditions and Supplementary Conditions, and the Specifications.

1.2 CONTENT AND PROCEDURE FOR REQUESTING PROGRESS PAYMENTS

A. Procedure:

1. Review with Resident Project Representative (RPR) quantities and the Work proposed for inclusion in each progress payment request. Application for Payment shall cover only the Work and quantities recommended by the RPR.
2. Contractor will review with Engineer or RPR the status of Project record documents, in connection with Engineer's review of each Application for Payment. Failure to maintain record document current will be cause for Engineer to recommend a reduction in payment for record documents in accordance with Section 01 29 73 - Schedule of Values, and will entitle Owner to set-offs in accordance with the Contract Documents.
3. Submit to Engineer complete Application for Payment and other documents to accompany the Application for Payment with Contractor's signature in electronic format.
4. Engineer will act on request for payment in accordance with the General Conditions and Supplementary Conditions.

B. Content: Each request for payment shall include:

1. Completed Application for Payment form, including summary/signature page, progress estimate sheets, and stored materials summary. Progress estimate sheets shall have the same level of detail as the Schedule of Values.
2. Documentation for Stored Materials and Equipment:
   a. For materials and equipment not incorporated in the Work but suitably stored, submit documentation in accordance with the General Conditions and Supplementary Conditions.
   b. Photographs of the stored items at the storage location, in accordance with requirements for progress photographs in Section 01 42 00 - References. Submit photographs sufficient to clearly indicate each stored item, clearly showing marking of Owner's property in accordance with Paragraph 1.3.C of this section. Such photographs do not count as photographs required under Section 01 42 00 - References. For each month that such item(s) are stored, take and submit monthly new photographs of each stored item, with date-stamp on each photograph.
   c. Legibly indicate on invoice or bill of sale the specific stored materials or equipment included in the payment request and corresponding bid/payment item number for each and the Supplier price for each item.

3. _____.
4. Listing of Subcontractors and Suppliers:
   a. In accordance with the General Conditions, submit not less than monthly updated listing of all Subcontractors and Suppliers known to Contractor, whether or not such entities have a contract directly with Contractor.
   b. Submit complete information using the form attached to this Specifications section.
5. Partial Release or Reduction of Retainage:
   a. For each Application for Payment where Contractor requests partial release or reduction of retainage in any amount (other than request for final payment), submit with associated progress payment request consent of surety to partial release or reduction of retainage, duly completed by Contractor and surety.
   b. Acceptable form includes AIA G707A, “Consent of Surety to Reduction in or Partial Release of Retainage” (1994 or later edition), or other form acceptable to Owner.
   c. For payment requests that include reduction in or payment of retainage in an amount greater than that required by the Contract Documents, obtain Owner’s concurrence for partial release or reduction in retainage prior to submitting such Application for Payment.

C. Final Payment:
   1. Requirements for request for final payment are in the General Conditions, as may be modified by the Supplementary Conditions, and Section 01 77 19 - Closeout Requirements.

1.3 ADDITIONAL PROCEDURES FOR PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Restrictions:
   1. Provisions of the General Conditions, as may be modified by the Supplementary Conditions, notwithstanding, only the following items of materials or equipment will be eligible for payment when suitably stored, prior to incorporation into the Work:
      a. Vertical Turbine Pumps and Pump Motors
      b. Flowmeters
      c. Check Valves
      d. Butterfly Valves
      e. Variable Frequency Drives
      f. Master Control Panel
      g. Electrical Switchboards
      h. Traveling Screen
      i. 150kW Generator

B. Observation of Stored Materials and Equipment as Condition Precedent to Eligibility for Payment:
   1. General:
      a. Prior to materials or equipment suitably stored but not yet incorporated into the Work can be eligible for payment, Engineer or Resident Project Representative (RPR) shall visit the storage location and verify the extent, condition, and storage environment of the stored items.

b. When the same material or equipment item is stored for more than two months, such visits to storage location shall be not less than once every two months.

2. Cost Responsibility for Observations:

a. When storage location is less than 20 miles from the Site or less than 20 miles from Engineer's office, Contractor is not responsible for reimbursing Owner for cost of Engineer's time and expenses for observing stored materials and equipment.

b. When storage location is more than 20 miles from the Site and more than 20 miles from Engineer's office, Contractor shall reimburse Owner, via a set-off under the Contract Documents, for reasonable cost of Engineer's time and expenses, including travel time, to visit the storage location and observe the stored materials and equipment.

C. Other Requirements for Stored Items: Regardless of storage location, perform the following for stored materials and equipment for which payment is sought:

1. Clearly mark each stored container, crate, or item as follows: "Property of Department of the Interior, Bureau of Indian Affairs" using permanent marking. Such marking shall not blemish or deface the finish of items that will be exposed to view after installation at the Site.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The forms listed below, following this Specifications section's "End of Section" designation, are part of this Specifications section:

1. List of Subcontractors and Suppliers form (two pages).

END OF SECTION

LIST OF SUBCONTRACTORS AND SUPPLIERS

Owner: U.S. Department of the Interior, Bureau of Indian Affairs
Project Name: Bannock Pumping Plant Modernization

Contractor: _____ Date: _____
Contract Designation: _____

Indicate below complete information for each Subcontractor and Supplier known to Contractor, regardless of whether the firm has a direct contract with Contractor. Include all lower-tier Subcontractors and associated Suppliers. Copy and paste the paragraphs below as required to indicate all Subcontractors and Suppliers.

SUBCONTRACTORS

1. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

2. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

3. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

Total of Subcontract Prices for all subcontracts equals approximately _____percent of the Contract Price *(Contractor to fill in blank monthly)*

SUPPLIERS

1. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

2. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

3. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for the following types of conferences and meetings required during the Work:
   a. Requirements applicable to all conferences.
   b. Preconstruction conference(s).
   c. Construction progress conferences.
   d. Closeout conference(s).
   e. Other construction conferences.

B. Scope:

1. This Section addresses the types of conferences indicated in Paragraph 1.1.A of this Section.

2. Requirements for monthly schedule meetings are in Section 01 32 16 - Construction Progress Schedule.
3. Requirements for pre-installation conferences, if any, are in the Specifications of Divisions 02-49.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 29 76 - Progress Payment Procedures.
2. Section 01 32 16 - Construction Progress Schedule.

1.2 REQUIREMENTS APPLICABLE TO ALL CONSTRUCTION CONFERENCES

A. Requirements of this Article apply to all conferences required under this Section.

B. Participants:

1. Lead participant for each participating entity of each conference shall be authorized to represent their employer and its interests on the Project, and shall be sufficiently familiar with the status of their employer's work, services, and activities related to the Project for purposes of the associated conference.
2. Required participants for each type of conference are indicated elsewhere in this Section.
3. Failure to participate by required participants:
   a. Should a required participant be unavailable for a required conference, inform the designated conference chair not less than one day prior to start of the subject conference. Furnish both oral (either in person or via telephone) and written communication regarding planned non-attendance. Expressly indicate the authorized substitute person who will be empowered to represent that entity at the conference.
   b. Failure to properly inform the conference chair as required, or repeated or habitual non-participation by mandatory participants, will be grounds for Owner to withhold (as "set-offs") amounts for mandatory meeting attendance from payments due Contractor under the Contract.
   c. Sending as a substitute lead participant an authorized representative who is ill-informed of their organization's work status and administrative matters related to the Project, or who is not properly authorized to represent their employer for all required matters indicated on the agenda, will be grounds for Owner to withhold payment, as set-offs, of amounts associated with such unpreparedness.

d. Should Contractor fail to attend without proper, advance notice to conference chair or furnish ill-prepared or unauthorized substitute lead participant, Contractor shall bear full responsibility, including cost- and time-related impacts, for lack of coordination, progress, and other, potentially adverse effects.

4. Conduct:
   a. Conference participants shall, at all times, exhibit appropriate, professional conduct and demeanor.
   b. Inappropriate conduct, including shouting, unprofessional language, threatening attitudes, or other types of insult or intimidation are unacceptable.
   c. Conference chair has the authority to eject from a conference, participants exhibiting inappropriate conduct.
   d. Person's exhibiting repeated or habitual inappropriate conduct will not be allowed to participate in conferences. Such person's employer and the contracting party they represent shall bear full responsibility for consequences of actions by its employees and representatives.

C. Agenda:
   1. Each conference required by this Section shall have an established, written agenda available to required attendees not less than one day prior to the subject conference, unless extenuating circumstances dictate a shorter time period.
   2. Unless written agenda specific to a given conference is issued in writing, the default agenda shall be in accordance with this Section.
   3. If a person or entity intending to participate in a required conference desires that such conference should address a given topic not already part of the typical agenda indicated in this Section, a written request for such topic to be added to the agenda must be received by the conference chair not later than four days prior to the scheduled start of such conference.
   4. The agenda may be amended at the outset of the conference, by consent of a majority of conference participants. Thereafter, the conference will be conducted, and topics discussed will be in accordance with the established agenda, as may be modified in accordance with this paragraph.

D. Conference Date, Time, and Location:
   1. Date, start time, anticipated duration, and location of each required conference will be established by conference chair, unless otherwise indicated in the Contract Documents.
   2. Conference chair will advise, in writing, required participants of conference date, start time, anticipated duration, and location. Such information may be transmitted as part of an agenda. Upon mutual agreement of required participants, date, start time, anticipated duration, and location of recurring conferences, such as construction progress conferences, may be initially established at the outset of the series and, therefore, do not require written advisory for each individual conference.
   3. Change of Conference Date, Time, or Location:
      a. In general, required conferences will be held on the date, at the time, and at the location required.
      b. Designated conference chair may, at their sole discretion, elect to change the conference date, start time, duration, location, or any combination thereof. Such change, if any, shall be communicated in writing to all required conference participants, and others as appropriate. Contractor is responsible for communicating changes to its Subcontractors and Suppliers.
      c. Notice of such change shall be communicated in accordance with Section 01 31 26 – Electronic Communication Protocols, not later than one day prior to scheduled start of the subject conference. Such changes may be communicated by distributing a written agenda for the subject conference, expressly indicating changes from previous arrangements.

d. When changes in date, time, or location are necessary less than the period indicated in the paragraph immediately above, such changes shall be communicated orally, whether in-person or via telephone. When communicated via telephone, calls shall be made to all of the participant's designated telephone numbers on file with the conference chair. Persons intending to participate in such conference are encouraged to check their voicemail and written communications prior to departing for the conference.

E. Minutes:

1. For each conference required in this Section, the conference chair will be responsible for preparing and distributing a written record ("minutes") of the conference proceedings, unless expressly indicated otherwise for a specified type of conference.
2. Purpose of minutes is to furnish a written record of the following for the associated conference: participants (indicating whether each individual participated in-person, virtually, arrived late, or departed early), topics discussed, questions asked and answered, and decisions made, and other pertinent matters as indicated on the established agenda for the associated conference. Minutes are not intended as a transcript or as complete record of minutia discussed at the associated conference.
3. Distribution of Minutes:
   a. Minutes will be distributed promptly after the associated conference.
   b. Minutes will be distributed, in accordance with Section 01 31 26 - Electronic Communication Protocols.
   c. Minutes will be distributed to all conference participants, personnel invited to or required to attend the conference but who did not attend or participate, and others as appropriate.
   d. Unless indicated otherwise in this Section or elsewhere in the Contract Documents, minutes of conferences required by this Section will be distributed to Owner, Owner's facility manager, Contractor, and Resident Project Representative.
4. Amendment of Minutes:
   a. Minutes distributed by, or on behalf of, the conference chair are subject to comments and potential amendments by other attendees of the subject conference. The period for commenting on, or requesting amendments to, minutes is limited to 30 days following initial distribution of the minutes, unless indicated otherwise elsewhere in the Contract Documents.
   b. Comments or requests for amendments may be furnished at the next, subsequent meeting in the same series of conferences. For example, comments on minutes of a construction progress conference may be presented at the next, subsequent construction progress conference. Comments on the minutes of the preconstruction conference may be presented at the first construction progress conference unless the designated time limit for requesting amendments has elapsed prior to the first progress conference.
   c. Minutes may be amended either by issuing revised minutes for the subject conference or by appropriate indication in the minutes of the next, subsequent conference in the same series, at the sole discretion of the conference chair.
   d. Conference chair has sole authority to accept or reject comments or requests for amendments on previously issued minutes.
   e. In general, requests, by persons who participated in the subject conference, for amendments to minutes will be given greater consideration by conference chair than request for amendments received from persons who did not participate in the subject conference.
   f. Should a person or entity believe the final minutes do not accurately reflect their opinion of how events transpired at the subject conference, such person or entity may prepare and submit appropriate correspondence presenting their viewpoint.

1.3 PRECONSTRUCTION CONFERENCES

A. The requirements of Article 1.2 of this Section also apply to this Article.

B. Preconstruction Conferences - General:

1. Purpose of preconstruction conference is reviewing administrative and procedural requirements, site mobilization matters, coordination with utility owners, and related matters. Required agenda, unless otherwise amended by conference chair, is indicated in this Article.
2. Conference Chair: Resident Project Representative.
3. Location, Date, and Time:
   a. Preconstruction conference will be held in indicate building and room designation, as appropriate at the Site.
   b. Preconstruction conference will be held following the Effective Date of the Contract on a day and at a time to be established by Engineer, following consultation with principal representatives of Owner, Owner's facility manager, Contractor, and other required participants. Preconstruction conference will be held prior to commencement of the Work at the Site.
   c. Anticipated duration of preconstruction conference is three hours, followed by time necessary for visiting the Site.
   d. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
4. Required Participants:
   a. Owner: Project manager.
   b. Owner's Facility Manager: Indicate appropriate personnel/roles.
   c. Contractor: Project manager and site superintendent.
   d. Engineer: Project manager or delegate.
5. Required participants may invite to the preconstruction conference others they deem necessary or appropriate.
6. Designation of Authorized Representatives:
   a. Either prior to or at the preconstruction conference, Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

C. Agenda:

1. Procedural and Administrative:
   a. Personnel and Teams:
      1) Designation of roles and personnel.
      2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
      3) Subcontractors and Suppliers in attendance.
      4) Authorities having jurisdiction.
   b. Procedures for communications and correspondence, including electronic communication protocols.
   c. Copies of the Contract Documents and availability.
   d. The Work and Scheduling:
      1) General scope of the Work.
      2) Contract Times, including Milestones (if any).
      3) Phasing and sequencing.
      4) Preliminary Progress Schedule.

5) Critical path activities.

e. Safety and Protection:
   1) Responsibility for safety.
   2) Contractor's safety representative.
   3) Emergency procedures and accident reporting.
   4) Emergency contact information.Confined space entry permits.
   5) Hazardous materials communication program.
   6) Impact of the construction on public safety.
   7) Responsibilities for protection of property.

f. Review of insurance requirements and insurance claim procedures.

g. Coordination:
   1) Coordination of Subcontractors and Suppliers.
   2) Construction coordinator (for projects with multiple prime construction contracts and locations where multiple projects may be underway simultaneously in reasonable proximity to each other).
   3) Coordination with Owner's operations.
   4) Construction progress conferences – schedule and frequency.
   5) Coordination conferences with other, separate projects.

h. Submittals:
   1) Current Critical Submittals:
      a) Preliminary schedules – Progress Schedule, Schedule of Submittals, Schedule of Values.
      b) Preconstruction photographic documentation.
      c) List of proposed Subcontractors and Suppliers using the form included in Section 01 29 76 - Progress Payment Procedures.
      d) List of emergency contact information.
      e) Notice of elements of Contractor's safety program with which Owner and Engineer are to comply.
      f) Form of Contractor's site superintendent's daily reports.
   2) Work is ineligible for payment without approved or accepted Submittals (as applicable).
   3) Submittal procedures.
      a) Compliance with accepted Schedule of Submittals.
      b) Actions required of Contractor prior to furnishing Shop Drawings and other Submittals.
      c) Contractor's Submittal approval stamp required; Contractor's coordination of Submittals.
      d) Furnishing of Submittals.
      e) Submittal types and meaning of Engineer's action on each.
      f) Resubmittals—responsibility for, limitations on quantity.
   4) Identification of initial, critical Shop Drawings and product data.
   5) Construction photographic documentation.

i. Substitutes and "Or-Equals":
   1) Product options.
   2) Procedures for proposing "or-equals".
   3) Procedures for proposing substitutes.

j. Contract Modification Procedures:
   1) Requests for interpretation.

2) Written clarifications.
3) Field Orders.
4) Proposal Requests.
5) Change Proposals.
6) Work Change Directives.
7) Change Orders.
8) Differing site conditions or discovery of unanticipated Hazardous Environmental Condition.
9) Substantiating and documenting Change Proposals and Claims.
10) Claims.

k. Progress Payment:
1) Owner's Project financing and funding, as applicable.
2) Owner's tax-exempt status.
3) Preliminary Schedule of Values
4) Procedures for measuring for payment (Unit Price Work).
5) Retainage.
6) Progress payment procedures; documents to accompany Applications for Payment.
7) Payment for stored items not yet installed.
8) Date of Owner's payments; payment is due.

l. Subcontractors and Suppliers:
1) List of proposed Subcontractors and Suppliers; monthly updates.
2) Coordination and management.
3) Subcontracts and purchase orders.

m. Testing and inspections:
1) Owner-hired and contractor-hired.
2) Identification of Owner-hired testing entity and special inspectors.
3) Responsibility for advising testing entity and special inspectors of need for services.
4) Results of code-required special inspections and tests.
5) Prompt remedy of apparent defects.
6) Notices of defective Work.
7) Remedy of defective Work.
8) Defective Work is ineligible for payment.
9) Covering up defective Work.
10) Cost responsibility for defective Work and retesting/re-inspection.

n. Disposal of demolition and spoil materials.

o. Record documents.

p. Preliminary discussion of Contract closeout:
1) Procedures for Substantial Completion.
2) Partial utilization procedures; property insurance.
3) Contract closeout requirements.
4) Correction period; duration of Contractor's general warranty and guarantee.
5) Duration of bonds and insurance.

2. Authorities Having Jurisdiction (if not covered in a separate conference):

a. Municipal licenses.

b. Municipal permits required.
1) Permits required and status.

2) Inspections for building code official.
3) Code-required special inspections and tests (if not covered in Administrative and Procedures part of conference).

c. Right-of-way work permits; status of occupancy permit(s).

d. Environmental permits:

1) Spill prevention control and countermeasures plan (40 CFR 112).

3. Site Mobilization (if not covered in a separate conference):

a. Working days, working hours, and overtime.

b. Use of Site and other areas; use of existing facilities.

c. Field offices, storage trailers, and staging areas.

d. Temporary facilities.

e. Temporary utilities and limitations on utility use (where applicable).

f. Utility company coordination (if not done as a separate conference).

g. Access to Site, access roads, and parking for construction vehicles.

h. Traffic controls.

i. Temporary controls:

1) Erosion and sediment control; storm water pollution prevention plans.
2) Dust control and air pollution control (including emissions control).
3) Water control (storm water, surface water, groundwater).
4) Water pollution control; spill prevention control and countermeasures plan.
5) Solid waste control.
6) Pest control.
7) Other temporary controls.

j. Temporary security; temporary security fencing (where required).

k. Storage of materials and equipment to be incorporated into the Work.

l. Protection of the Work and property; protective barriers.

m. Field engineering:

1) Reference points and benchmarks.
2) Surveys and layouts.
3) Professional services for Contractor's means and methods (not delegated design).
4) Contractor's site superintendent's daily records and submittal requirements.

n. Site maintenance during the Project:

1) Progress cleaning; removal of trash and debris.
2) Maintenance and cleaning of existing access roads and parking areas.

o. Restoration.

4. Next conference.

5. Site visit, as necessary.

1.4 CONSTRUCTION PROGRESS CONFERENCES

A. The requirements of Article 1.2 of this Section also apply to this Article.

B. Construction Progress Conferences - General:

1. Purpose of construction progress conferences is to review and summarize Work performed since the previous construction progress conference; review and summarize planned progress through the next, subsequent construction progress conference; review and summarize compliance with the Progress Schedule; review progress and necessary actions on pending and critical administrative items; discuss matters pertinent to the Site and construction quality; and other matters.

2. Conference Chair: Resident Project Representative.
3. Location, Date, and Time:
   a. Construction progress conferences will be held in Contractor's field office at the Site.
   b. Frequency: construction progress conferences will be held once per week. Such conferences are in addition to other recurring conferences that may be required elsewhere in the Contract Documents.
   c. Construction progress conferences will be held following preconstruction conference on a day and at a time to be established by Resident Project Resident, following consultation with principal representatives of Owner, Contractor, and other required participants. Timing on which construction progress conferences will commence will be at the discretion of the designated chair of construction progress conferences.
   d. Construction progress conferences required by this Section are separate from monthly schedule meetings required in Section 01 32 16 - Construction Progress Schedule.
   e. Anticipated duration of each construction progress conference is two hours, plus time necessary for visiting the Site.
   f. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
4. Required Participants:
   a. Owner: Owner's site representative and Owner's construction coordinator.
   b. Owner's Facility Manager: Fort Hall Irrigation Project Field Manager or Delegate.
   c. Contractor: Project manager, site superintendent, and safety representative.
   d. Principal Subcontractors: Project manager or site superintendent, for Subcontractors performing significant Work since the previous conference and that will perform significant Work prior to the next, subsequent construction progress conference. When Subcontractor's site superintendent represents Subcontractor at construction progress conferences, site superintendent shall be authorized and informed of administrative matters relating to Subcontractor's Work in accordance with Article 1.2 of this Section.
   e. Major Suppliers: Field representative of Suppliers of significant materials and equipment, when such field representatives are performing onsite services under the Contract, or as otherwise deemed necessary by Contractor relative to conference participation.
   f. Engineer: Resident Project Representative.
5. Required participants may invite to construction progress conferences others they deem necessary or appropriate.

C. Handouts:
1. Contractor shall bring to each construction progress conference not less than 10 paper copies of each of the following:
   a. List of Work accomplished since the previous construction progress conference and list of construction activities planned through the next, subsequent construction progress conference. Coordinate list of planned activities with both the updated Progress Schedule and look-ahead schedule.
   b. Up-to-date Progress Schedule, in accordance with Section 01 32 16 - Construction Progress Schedule.
   c. Up-to-date Schedule of Submittals, in accordance with Section 01 33 00 - Submittal Procedures.
   d. "Look-ahead" schedule, in accordance with Section 01 32 16 - Construction Progress Schedule.
   e. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

D. Preliminary Agenda for Construction Progress Conferences:
1. Review, comment, and amend (if necessary) of minutes of previous progress conference.

2. Review of progress since the previous progress conference.
3. Planned progress through next progress conference.
4. Overview of Progress Schedule:
   a. Review of the Contract Times; Contractor's ability to comply with Contract Times.
   b. Identification of critical path activities.
   c. Schedules for fabrication and delivery of materials and equipment.
   d. Corrective measures, if necessary, including recovery schedule(s).
5. Submittals:
   a. Review status of critical Submittals.
   b. Review revisions to Schedule of Submittals.
6. Contract Modifications:
   a. Requests for interpretation.
   b. Written clarifications.
   c. Field Orders.
   d. Proposal Requests.
   e. Change Proposals.
   f. Work Change Directives.
   g. Change Orders.
   h. Claims.
7. Progress Payment Requests:
   a. Status and deadline for submittal.
   b. Stored materials and equipment; observation by Engineer or RPR; documents required.
   c. Set-offs to which Owner is entitled (as applicable).
   d. Other matters related to progress payments.
8. Problems, conflicts, and observations.
9. Quality standards, testing, and inspections.
10. Coordination between Project participants.
11. Site management issues, including vehicular access and parking, traffic control, security, status of temporary controls and temporary utilities, site maintenance and cleaning, and other Site matters.
12. Safety and protection.
13. Permits and compliance.
14. Construction photographic documentation.
15. Record documents status.
16. Completion matters (as appropriate):
    a. Status of checkout, startup, field quality control activities.
    b. Status of training of facility O&M personnel and O&M manuals.
    c. Partial utilization; requesting and scheduling inspection for Substantial Completion.
    d. Punch list status (as applicable).
    e. Other closeout matters (if any).
17. Other business.

1.5 CLOSEOUT CONFERENCES

A. The requirements of Article 1.2 of this Section also apply to this Article.

B. Closeout Conferences – General.

1. Purpose of closeout conferences is to familiarize participants with administrative and procedural requirements for Substantial Completion (including partial utilization by Owner)

and readiness for final payment, and status of the Work required for achieving Substantial Completion and readiness for final payment.

2. Conference Chair: Same as indicated elsewhere in this Section for construction progress conferences.
3. Location, Date, and Time:
   a. Location, date, and time will be the same as indicated elsewhere in this Section regarding construction progress conferences.
   b. In general, as the Work, or a designated part thereof, progresses toward Substantial Completion, topics addressed at construction progress conferences will transition to discussing closeout-related topics.
   c. The conference chair may require one or more additional closeout conferences as the conference chair deems necessary. Required participants shall participate in such conferences without changes in the Contract Price or the Contract Times.
   d. Should additional closeout conferences be necessary, or should location, date, or times for closeout conferences differ from those established for construction progress conferences, the conference chair will so advise required participants, and others as appropriate, in accordance with Article 1.2 of this Section.
4. Required Participants: Same as required participants for construction progress conferences, unless otherwise indicated by conference chair.

C. Preliminary Agenda for Closeout Conferences:
   1. Same as “Completion matters” portion of preliminary agenda for construction progress conferences as indicated elsewhere in this Section.
   2. Checkout and startup planning meeting, in accordance with Section 01 75 00 - Checkout and Startup Procedures.
   3. Training schedule conference, in accordance with Section 01 79 23 - Instruction of Operation and Maintenance Personnel.
   4. Additional closeout related topics as determined by closeout conference chair.

1.6 OTHER CONSTRUCTION CONFERENCES

A. The requirements of Article 1.2 of this Section also apply to this Article.

B. Other Construction Conferences – General.
   1. Other construction conferences may be scheduled and held as deemed necessary by Owner or Engineer. Such conferences may be focused on specific matters, such as discussing remedies and schedules for defective Work, negotiating changes in the Contract Price and Contract Times, or other matters related to the Project where time limits prevent addressing such items as part of other conferences addressed elsewhere in the Contract Documents.
   2. Conference Chair: Resident Project Representative.
   3. Location, Date, and Time:
      a. Location: Same as location of construction progress conferences as indicated elsewhere in this Section, unless location is changed in accordance with Article 1.2 of this Section.
      b. Other construction conferences will be held on a day and at a time to be established byResident Project Representative, following consultation with principal representatives of Owner, Owner’s facility manager, Contractor, and other required participants.
      c. Each other construction conference is one hour, plus time that may be necessary for visiting the Site when conference purpose warrants.
      d. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
   4. Required Participants: As deemed necessary by conference chair.

C. Agenda: Agenda presenting topics to be discussed at each other construction conference will be developed by the conference chair and distributed to required participants, and others as appropriate, in accordance with Article 1.2 of this Section.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 31 26
ELECTRONIC COMMUNICATION PROTOCOLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Procedures with which Users will comply regarding transmission or exchange of Electronic Documents for the Project.

B. Related Requirements:

1. In addition to the requirements of this Specifications Section, comply with the requirements for Electronic Documents in the following Specifications:
   a. Section 01 32 16 – Construction Progress Schedule.
   b. Section 01 33 00 – Submittal Procedures.
   c. Section 01 78 39 – Project Record Documents.

1.2 DEFINITIONS

A. The following terms are defined for use in this Specifications Section and are indicated herein using initial capital letters. The terms have the associated meaning regardless of whether indicated in singular or plural.

1. Electronic Documents Protocol (abbreviated as “EDP”): Procedures and requirements set forth in this Specifications Section for the exchange of Electronic Documents by Electronic Means.
2. Project Website: An internet-based software platform, such as a website or other project management information system (PMIS) designated by Contract or mutual consent of Users as the means of exchanging Electronic Documents during the Project.
3. System Infrastructure: Hardware, operating system(s) software, internet access, e-mail service and software, security software, and large-file transfer functions.
4. Users: Owner, Contractor, Engineer, and others exchanging Electronic Documents on the Project in accordance with the EDP.

1.3 ADMINISTRATIVE REQUIREMENTS.

A. Coordination:

1. Contractor shall require all Subcontractors and Suppliers to comply with the EDP established in the Contract Documents.

1.4 GENERAL PROVISIONS OF ELECTRONIC DOCUMENT PROTOCOL

A. EDP – General:

1. To the fullest extent practical, Users agree to and will transmit and accept Electronic Documents transmitted by Electronic Means in accordance with the requirements of this Specifications Section. Use of the Electronic Documents and any information contained therein is subject to requirements of this Specifications Section and other provisions of the Contract Documents governing transmittal of Electronic Documents.
2. Content of Electronic Documents will be the responsibility of transmitting User.
3. Unless otherwise provided in: (1) the EDP, (2) elsewhere in the Contract Documents, or (3) or other agreement between two or more Users governing use of Electronic Documents, Electronic Documents exchanged in accordance with the Contract Documents may be used in the same manner as paper or other printed versions of the same documents exchanged using other than Electronic Means, subject to the same governing requirements, limitations, and restrictions set forth in the Contract Documents.

4. Except as otherwise explicitly indicated in the EDP, the terms of this EDP will be incorporated into any other agreement or subcontract between a party and a third party for a portion of the Work or Project-related services, where such third party is, either directly or indirectly, required to exchange Electronic Documents with Owner, Contractor, or Engineer. Nothing in this EDP modifies the requirements of the Contract Documents regarding communications between and among Owner, Contractor, and Engineer Subcontractors, Suppliers, consultants, and others for which each is responsible.
5. When transmitting Electronic Documents, transmitting User makes no representations regarding long-term compatibility, usability, or readability of the items resulting from the receiving User's use of software applications or System Infrastructure differing from those established in this EDP.
6. This EDP does not negate or mitigate any obligation: (1) in the Contract Documents to create, provide, or maintain an original paper record version of Drawings and Specifications, signed and sealed in accordance with Laws or Regulations; (2) to comply with Laws and Regulations governing signing and sealing of design documents or signing and electronic transmission of other documents; or (3) to comply with notice requirements of the General Conditions (as. May be modified by the Supplementary Conditions).
7. Modifications to EDP:
   a. When modifications to the EDP are necessary to address issues affecting System Infrastructure, Users shall cooperatively resolve the issues.
   b. If resolution within a reasonable time is not achieved, Owner is empowered to require reasonable and necessary changes to the EDP consistent with the original intent of the EDP.
   c. If such changes result in additional cost or delay to Contractor, not reasonably anticipated under the original EDP, Contractor may seek an adjustment in the Contract Price, Contract Times, or both in accordance with the Contract Documents.

B. System Infrastructure and Systems for Exchanging Electronic Document:

1. Each User will provide System Infrastructure (as defined in this EDP) at its own cost and sufficient for complying with EDP requirements. Except for minimum standards set forth in this EDP, it is the obligation of each User to determine, for itself, such User's own System Infrastructure.
   a. Maximum size of e-mail file attachment under this EDP is 20 megabytes (MB). Attachments larger than the maximum size indicated in this paragraph shall be exchanged via secure electronic transfer using method mutually acceptable to Owner, Engineer, and Contractor.
   b. Each entity transmitting or receiving Electronic Documents has full responsibility for its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, and otherwise enabling its System Infrastructure for use in accordance with this EDP.
   c. Each User will provide its own printing facilities and will be responsible for its own costs of printing Electronic Documents.
2. Each User is responsible for its own system operations, security, back-up, archiving, audits, and other technology and resources for operations of its System Infrastructure during the Project, including coordination with the User's individual(s) or subcontractor(s) responsible for managing its System Infrastructure and capable of addressing communications and other technology issues affecting exchange of Electronic Documents.
3. Security:
   a. Each User will operate and maintain industry-standard, industry-accepted, ISO standard, commercial-grade security software and systems to protect against threats including software viruses and other malicious software including worms, trojans, adware; data breaches; loss of confidentiality; and other threats in transmission to, or storage of, Electronic Documents from other Users, including transmission of Electronic Documents by physical media including flash drives/thumb drives, hard drives, compact

discs (CD), digital video discs (DVD), and other portable devices, whether connected physically or wirelessly.

b. To the extent that a User maintains and operates such security software and appropriate System Infrastructure, such User will not be liable to other Users participating in the Project for breach of system security.

4. Principal means of exchanging Electronic Documents will be e-mail and files attached to e-mail, in accordance with the EDP.

5. Project Website:

a. Engineer will establish, operate, and maintain a Project Website (as defined in this EDP) for use of Owner, Engineer, Contractor, and other Users as appropriate during the Project, for exchanging and storing Project Electronic Documents.

b. Unless otherwise provided in the Contract Documents, use of Project Website by Owner, Contractor, and Engineer is mandatory for exchanging Project documents as set forth in the EDP.

c. Project Website Conditions and Standards:

1) Project Management Information System or other Software Application(s): Newforma Info Exchange (Newforma).

2) Duration of Project Website Availability and Reliance by Users: 8 weeks beyond Project Closeout..

d. Address of Project Website will be furnished to Contractor, and Project Website will be available to Contractor, within 10 days following the Effective Date of the Contract.

C. General Requirements and Limitations for Software for Electronic Document Exchange:

1. Software and file formats for exchange of Electronic Documents shall be as indicated in Article 1.5 of this Specifications Section.

2. Software Versions:

a. Each User will acquire the software and associated licenses necessary to create, transmit, receive, read, and us Electronic Documents for the Project, using the software and file formats indicate in Article 1.5 of this Specifications Section.

b. Prior to using any updated version of the software required in the EDP for Electronic Document(s) transmitted to other User(s), the originating User will first notify and either (1) receive concurrence from receiving User(s) for use of the updated version, or (2) adjust its transmission to comply with the EDP.

3. Preservation of Intellectual Property and Confidentiality of Electronic Documents:

a. Users agree to not intentionally edit, reverse-engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes Electronic Documents, and information and data contained therein, transmitted in a file format, including portable document format (PDF), intended by transmitting User to not be modified, unless the receiving User (1) obtains permission from owner of the Electronic Document and intellectual property contained therein, or (2) is expressly allowed by the EDP to edit or modify the Electronic Document.

b. Where modifying, editing, decryption, or reverse-engineering is allowed by the EDP, such use is conferred only for the Project.

c. The EDP does not transfer any ownership or rights of any sort regarding use outside of the Project of Electronic Documents.

d. Users shall not cite or quote excerpts of Electronic Documents for purposes outside of the Project unless required to do so by Laws and Regulations.

D. Contractor’s Requests for Electronic Documents in Other Formats:

1. Release of Electronic Documents in format(s) other than those indicated in in Article 1.5 of this Specifications Section and elsewhere in the Contract Documents will be at the discretion of Owner and subject to terms and conditions required by the owner of such files and documents, and the provisions indicated below.

2. To extent determined by Owner, in its sole discretion, to be appropriate, release of Electronic Documents in alternative format(s) requested by Contractor ("Request") are subject to provisions of Owner's response to the Request and to the following:
   a. Contractor's Request shall be in writing. Owner and others, as appropriate, will consider and respond to Request promptly, but neither Owner nor Engineer will be responsible for any time or cost impacts on Contractor associated with timing of the Request, or with Owner's decision associated therewith.
   b. When Engineer is the owner of the Electronic Documents requested by Contractor in native format, prior to Engineer transmitting such Electronic Documents to Contractor, Contractor shall sign and deliver to Engineer, without modifying or amending, Engineer's "Electronic Media Release" agreement.
   c. Content included in Electronic Documents created by Engineer and furnished in response to the Request was prepared by Engineer as an internal working document for Engineer's purposes solely and, when provided to Contractor, is on an "as-is" basis without warranties of any kind, including, but not limited to any implied warranties of fitness for purpose. Contractor acknowledges that content of Electronic Documents furnished in response to the Request may not be suitable for Contractor's purpose(s), or may require substantial modification and independent verification by Contractor. Content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other shown or indicated information that may affect subsequent use by Contractor or others for whom Contractor is responsible.
   d. Electronic Documents containing text, graphics, metadata, or other types of data furnished by Engineer in response to the Request are only for Contractor's convenience and any and all conclusions or information obtained or derived from such Electronic Documents will be at Contractor's sole risk and expense. Contractor waives any and all claims against Engineer, Owner, or both arising from Contractor's use of Electronic Documents furnished in response to the Request.
   e. Contractor shall indemnify and hold harmless Owner, Engineer, and their respective consultants and subconsultants from any and all claims, damages, losses, and expenses, including attorneys' fees and defense costs, fees and costs of engineers, architects, geologists, accountants, and other professionals, and any and all other costs, direct and indirect, resulting from Contractor's use, adaptation, or distribution of Electronic Document(s) furnished in response to the Request.
   f. Contractor shall not sell, copy, transfer, forward, give away or otherwise distribute the Electronic Documents (in source format or modified file format) to any third party without direct written authorization of Engineer or other entity that owns the Electronic document(s), unless such distribution is specifically indicated in the Request and is limited to Subcontractors and Suppliers. Contractor warrants that subsequent use by Subcontractors and Suppliers complies with terms and conditions of the Contract Documents, Owner's response to the Request, and release agreement(s) (if any) by owner of the Electronic Documents (including Engineer, where applicable).

1.5 EXCHANGE OF ELECTRONIC DOCUMENTS

A. Comply with the Electronic Document formats, transmission methods, and permitted uses set forth in Table 01 31 26-A, Exchange of Electronic Documents, below, when transmitting or using Electronic Documents on the Project. Where a row in the table has no indicated means of transmitting Electronic Documents, use for such documents only paper copies transmitted to the receiving party via appropriate delivery method.

TABLE 01 31 26-A – EXCHANGE OF ELECTRONIC DOCUMENTS

Electronic Document Type	Format	Transmitting User	Transmission Method	Receiving User	Allowed Uses	Notes
1.5.A.1. Project communications						
General communications & correspondence	EM, PDF	O, E, C	EM, EMA	O, E, C	R	
Meeting notices and agendas	EM, PDF	E	EM, EMA	O, C	R	
Meeting minutes	PDF	E	EM, EMA	O, C	R	
1.5.A.2. Contractor's Submittals to Engineer						
Shop Drawings	PDF	C	EMA	E	M (1)	(1)
Product data Submittals, delegated design Submittals, and other action Submittals (except Samples)	PDF	C	EMA	E	M (1)	(1)
Informational and closeout Submittals:	PDF	C	EMA	E	M (1)	(1) (6)
Documentation of delivery of maintenance materials submittals	PDF	C	EMA	E	M (1)	
1.5.A.3. Engineer's return of reviewed Submittals to Contractor						
Shop Drawings	PDF	E	EMA	O., C	R	
Product data Submittals, delegated design Submittals, and other action Submittals	PDF	E	EMA	O., C	R	
Informational and closeout Submittals:	PDF	E	EMA	O., C	R	(6)
Documentation of delivery of maintenance materials submittals	PDF	E	EMA	O. C	R	
1.5.A.4. Contract Modifications Documents						
Requests for interpretation to Owner and Engineer	PDF	C., O	EMA	E, O	M (1)	(1)
Owner's interpretations (RFI responses)	PDF	O	EMA	C, O	R	
Owner's clarifications to Contractor	EM, PDF	O	EM, EMA	C, O	R	
Owner's issuance of Field Orders	PDF	O	EMA	C, O	R	
Proposal Requests	PDF	E, O	EMA	C	R	
Change Proposals – submitted to Owner and Engineer	PDF	C	EMA	O, E	S	
Change Proposals – Owner's response	PDF	O	EMA	C. O		
Work Change Directives (for Contractor signature)	PDF	O	EMA	C	R	(2)
Change Orders (for Contractor signature)	PDF	O	EMA	C	R	(2)
1.5.A.5. Applications for Payment						(3)
1.5.A.6. Claims and other notices						(4)
1.5.A.7. Closeout Documents						
Record drawings	DWG and PDF	C	EMA	E, O	M (5)	(5)
Other record documents	PDF	C	EMA	E. O	M (5)	(5)

Electronic Document Type	Format	Transmitting User	Transmission Method	Receiving User	Allowed Uses	Notes
Contract closeout documents						

1. Key to Table 01 31 26-A:
   a. Data Format:
      1) EM: .msg, .htm, .txt, .rtf, e-mail text.
      2) W: .docx, Microsoft Word 2013 or later.
      3) EX: .xlsx, Microsoft Excel 2013 or later.
      4) PDF: .pdf. portable document format.
      5) DWG: .dwg. Autodesk AutoCAD 2014 drawing.
   b. Transmitting User:
      1) O: Owner.
      2) C: Contractor.
      3) E: Engineer.
   c. Transmission Method:
      1) EM: Via e-mail.
      2) EMA: Attachment to e-mail transmission.
      3) PORT: Delivered via portable media such as flash drive/thumb drive, CD, or DVD
      4) PW: Posted to Project Website.
      5) FTP: FTP transfer to receiving FTP server.
   d. Receiving User:
      1) O: Owner.
      2) C: Contractor.
      3) E: Engineer.
   e. Permitted Uses:
      1) S: Store and view only.
      2) R: Reproduce and distribute.
      3) I: Integrate (incorporate additional electronic data without modifying data received)
      4) M: Modify as required to fulfill obligations for the Project.
   f. Notes:
      1) Modifications by Engineer to Contractor's Submittals and requests for interpretations are limited to printing, marking-up, and adding comment sheets.
      2) May be distributed only to affected Subcontractors and Suppliers. Print, sign document, and return signed paper originals to Engineer.
      3) Submit printed Applications for Payment with original ("wet") signatures.
      4) Submit notices, including Claims, in accordance with the notice provisions of the General Conditions, as may be modified by the Supplementary Conditions.
      5) Submit record drawings in native CAD format indicated when Contractor has signed Engineer's standard agreement for release of electronic media. In addition, always submit record drawings as PDF files. Comply with Contract Documents requirements for Project record documents.
      6) For operation and maintenance data, also submit paper copies as required by Section 01 78 23 - Operations and Maintenance Manuals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for Contractor's construction Progress Schedules and related Submittals, including:
   a. Administrative requirements regarding progress Schedules.
   b. Qualifications of Progress Schedule preparer and related personnel.
   c. Submittals of Progress Schedules and associated schedule-related Submittals..
   d. Initial Progress Schedules.
   e. Look-ahead schedules.
   f. Progress Schedule updates.
   g. Narrative reports.
   h. Time impact analyses.
   i. Recovery schedules.

B. Scope:

1. Contractor shall prepare and submit to Engineer required Progress Schedules and related Submittals, as required by this Section and elsewhere in the Contract Documents. Maintain and update Progress Schedules and related Submittals throughout the Project.
2. Owner, facility manager (if other than Owner), Engineer, and others involved with the Project have the right to rely on accuracy of Contractor-prepared Progress Schedule.
3. Engineer's review or acceptance of the Progress Schedule or related Submittals, and Engineer's comments on and expressed opinions concerning activities in the Progress Schedule and related Submittals, and progress of the Work, does not control Contractor's independent judgment concerning construction means, methods, techniques, sequences and procedures, unless the associated means, method, technique, sequence, or procedure is required by the Contract Documents. Contractor is solely responsible for complying with the Contract Times.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 11 00 - Summary of Work.
2. Section 01 14 16 - Coordination with Owner's Operations.
3. Section 01 31 19 - Project Meetings.

1.2 REFERENCES.

A. Defined Terms and Terminology:

1. Defined terms, indicated with initial capital letters, are indicated in the General Conditions, as may be modified by the Supplementary Conditions.
2. Terminology: The following are not defined terms and are not indicated with initial capital letters but, when used in this Section, have the meaning indicated below, whether applied to the singular or plural thereof.
   a. "Activity" is an element of the Work that has the following specific characteristics: consumes time, requires resources, has a definable start and finish, is assignable, and is measurable.
   b. "Baseline Progress Schedule" means, in addition to the General Conditions' definition of "Progress Schedule", the version of the Progress Schedule (for the entire Project) initially accepted by the Engineer. In the event of subsequent modifications to the

Project, Contractor and Engineer may mutually agree that a subsequent revision of the Progress Schedule constitutes a new baseline Progress Schedule that supersedes the prior baseline Progress Schedule.

c. “Constraint” means an imposed date on the Progress Schedule or an imposed time between activities. The Contract Times are constraints.

d. “CPM Progress Schedule” means, in addition to the General Conditions’ definition of “Progress Schedule”, a computerized Progress Schedule in critical path method (CPM) format, for the entire Work, indicating interrelationships between elements of the Work; indicates sequences, dates, and durations for Work performed to date; indicates sequences, dates, and duration for incomplete Work yet to be performed; indicates constraints; and indicates the critical path for the Work.

e. “Critical path” is the continuous chain of activities, from start to completion of the Work, with the longest duration for completion within the Contract Times.

f. “Early finish” means the earliest date an activity can finish according to the assigned relationships among the activities in the Progress Schedule.

g. “Early start” means the earliest possible date an activity can start according to the assigned relationships among activities in the Progress Schedule.

h. “Float” means the time difference between the calculated duration of an activity chain on the Progress Schedule and the critical path.

i. “Late finish” means the latest date an activity on the Progress Schedule can finish without extending the Contract Times.

j. “Late start” means the latest date an activity on the Progress Schedule can start without extending the Contract Times.

k. “Network diagram” means a time-scaled logic diagram showing the durations and relationships of the activities on the Progress Schedule.

l. “Schedule date” (and similar terms, whether used in this Section or Project communications related to Progress Schedules) mean the “early start” and “early finish” date for the associated activity. “Late start” and “late finish” dates are for determining float and do not represent the schedule dates.

m. “Total float” means the total number of days an activity (or chain of activities) on the Progress Schedule can be delayed without affecting the Contract Times.

n. “Work areas” and “work system” means a logical breakdown of the Work elements or a group of activities which, when collectively assembled, are readily identifiable on the Project (for example: yard piping, a structure or building, a treatment process, or other logical grouping).

1.3 ADMINISTRATIVE REQUIREMENTS

A. General Provisions on Progress Schedules:

1. This Section augments requirements for the Progress Schedule, and Contractor’s control of the Work, indicated in the General Conditions, as may be augmented by the Supplementary Conditions..

B. Use of Float:

1. Float belongs to the Project and may be used by Contractor or Owner to accommodate changes in the Work, or to mitigate the effect of events delaying the Work or compliance with the Contract Times.
2. Changes or delays that influence activities that have float and do not extend the critical path do not justify changes in the Contract Times..
3. Float Suppression: Pursuant to float sharing requirements of this Section, use of float suppression techniques in Progress Schedules, such as preferential sequencing logic, special lead/lag logic restraints, and extended activity durations are unacceptable.

C. Factors Affecting the Progress Schedule:

a. In preparing and updating the Progress Schedule, take into consideration: preparing and signing subcontracts and purchase orders, complying with Submittal requirements and Submittal review times, fabricating materials and equipment, source quality control (including required shop tests and inspections), shipping and deliveries, field quality control (including required field tests and inspections at the Site), Work by Subcontractors, coordination with others (such as other contractors including those indicated in Section 01 11 00 – Summary of Work, utility owners, and owners of transportation facilities), compliance with Laws and Regulations and permits, availability of construction equipment and machinery, abilities of workers, weather conditions, condition of the Site, seasonal restrictions, restrictions in operations at the Site and coordination with Owner's (or facility manager's) operations, training of facility operation and maintenance personnel, checkout, startup, adjusting and balancing, and other factors that have the potential to affect completion of the Work within the Contract Times.

2. Comply with sequencing requirements including:
   a. Section 01 14 16 - Coordination with Owner's Operations.

D. Electronic Data Files:

1. The Contractor will provide the City's Representative with the source or "raw" data/electronic files in ".XER" format that can be viewed with the software used to develop the CPM schedule.
2. Do not employ any methods for locking data or preventing the City's Representative from reading the data using the latest version of Oracle Primavera P6.

E. Weather Delays:

1. Include an activity on the critical path of the schedule with a duration of five working days per year for delays due to adverse weather on the project. When the City's Representative and Contractor agree that a weather day affects the work, it will reduce the remaining duration of the weather day activity by the agreed on weather days.
   a. Adverse weather is considered when the temperature and/or precipitation exceeds the average temperature, precipitation and/or other weather event by 15 PCT as measured by the National Oceanic and Atmospheric Administration (NOAA) at the closest weather station to the project site and the adverse weather impacts the Contractor's delivery of material, availability of labor, or production of work. If the adverse weather does not affect delivery of material, availability of labor, or production of work, then it will not be considered adverse weather.
   b. The adverse weather must affect the work on the critical path at the time the adverse weather occurs.
   c. Any time not used in a calendar year may be carried over to the next year or considered float.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Progress Schedule Preparer.
   a. Contractor shall retain services of a scheduling consultant to, or shall self-perform, preparation and updating of the Progress Schedule using qualified personnel experienced in: (1) construction scheduling, (2) the scheduling software required for the Project, and (3) serving as Progress Schedule preparer on construction projects of similar type, size, and complexity as the Project.
   b. Progress Schedule preparer shall have not less than five years' experience using the required schedule software on construction projects of similar type, size, and complexity as the Project.
   c. Prior to engaging a scheduling consultant or using a qualified, experienced employee, submit to Engineer the following qualifications information:

1) Name, employer, and business address of proposed Progress Schedule preparer and names, employer(s), and business address(es) of personnel who will be assigned to assist the preparer in developing and updating the Progress Schedule.
2) Information sufficient to demonstrate that proposed Progress Schedule preparer and scheduling assistant personnel possess qualifications complying with this Section. For each person assigned, submit list of similar type, size, complexity, and construction contract amount for each project, together with project name, owner, location, and dates, and name(s) of scheduling personnel involved.

d. Engineer's Review of Qualifications:
1) Engineer will complete review of Progress Schedule preparer qualifications within seven working days of Engineer's receipt of such qualifications.
2) If qualifications are unacceptable, submit qualifications of acceptable personnel within seven working days of Contractor's receipt of Engineer's non-acceptance.
3) Engineer's acceptance or non-acceptance of qualifications does not reduce or mitigate Contractor's obligations under the Contract Documents.

e. If Contractor intends to replace any Progress Schedule preparer personnel previously acceptable to Engineer, submit qualifications of proposed replacement(s) in accordance with this Article.

1.5 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Qualifications Statements:
   a. Submit qualifications of Progress Schedule preparer, and other personnel that will assist Progress Schedule preparer in preparing and updating the Progress Schedule.
   b. Obtain Engineer's acceptance of qualifications prior to starting preparation of preliminary Progress Schedule.
2. Planned Work Schedule:
   a. Submit initial and updated (as necessary) planned work schedule, in accordance with this Section's "Progress Schedule" Article.
3. Progress Schedule:
   a. Preliminary Progress Schedule with associated narrative report.
   b. Acceptable Progress Schedule ("baseline Progress Schedule") with associated narrative report.
4. Look-Ahead Schedules:
   a. Submit three-weeklook-ahead schedule at each construction progress meeting, in accordance with this Section's "Look-Ahead Schedules" Article.
5. Progress Schedule Updates:
   a. Progress Schedule updates shall comply with requirements of this Section, and shall include updated Progress Schedule and narrative report.
   b. Submit updated Progress Schedule prior to each associated construction progress meeting. When a Progress Schedule remains unchanged from one construction progress meeting to the next, submit written statement expressly so stating. In addition to monthly Progress Schedule update Submittals, also bring to construction progress meetings the number of paper copies of the updated Progress Schedule indicated in Section 01 31 19 - Project Meetings.
6. Time Impact Analyses: Submit in accordance with this Section.
7. Recovery Schedules: Submit in accordance with this Section.

1.6 INITIAL PROGRESS SCHEDULES

A. Applicability of this Article:

1. This Article addresses the initial Progress Schedules and selected, related Submittals required at the outset of the Project's construction phase, through Engineer's acceptance of the Progress Schedule and its related Submittals.
2. Subsequent Progress Schedule Submittals, including Progress Schedule updates, recovery schedules, and other schedule-related Submittals, shall comply with software, type, organization, content, and similar requirements of this Article.

B. Type and Organization of Progress Schedules:

1. Prepare Progress Schedules using Oracle Primavera P6 software, unless other scheduling software is acceptable to Engineer.
2. Sheet Size: 22 inches by 34 inches, unless otherwise accepted by Engineer.
3. Time Scale: Indicate first date of each work week.
4. Activity Assignments and Designations:
   a. Limit activities, where possible, excluding fabrication of materials and equipment, to durations not longer than 20 days. Activities shall be definable and measurable. For example, an activity described only as "Concrete" will likely be unacceptable.
   b. Assign to each activity an appropriate, unique numerical designation and description.
   c. Numerical designation shall incorporate the associated Specifications section number.
   d. Activity description shall include sufficient detail to clearly communicate the intended activity. Descriptions shall include identifiers for physical locations of work area or work system, such as (where appropriate): column lines, stationing (for linear projects), and elevations. Indicate unique description for each activity.
   e. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
   f. Group construction into work area sub-schedules (that are part of the Progress Schedule) by activity.
   g. Clearly indicate, as activities separate from installation, necessary and required curing periods.
5. Organization of Progress Schedules:
   a. Indicate interfaces and dependencies with preceding, concurrent, and follow-on activities, including those associated with the Work, other contractors at the Site, Owner and facility manager, Owner's consultants (including Engineer), authorities having jurisdiction, and others as appropriate. Clearly indicate activities not under Contractor's control.
   b. Progress Schedules shall be CPM Progress Schedules.
   c. Indicate on the separate Schedule of Submittals dates for submitting and reviewing Shop Drawings, product data Submittals, Samples, and other required Submittals. Coordinate Progress Schedule with the Schedule of Submittals.
   d. Clearly indicate the critical path on the Progress Schedule.

C. Planned Work Schedule:

1. Within 10 days of the Effective Date of the Contract, indicate to Engineer the work days and hours proposed by Contractor. Also indicate planned non-work days, such as Contractor's holidays, weekends, and the like.
2. Enforce Subcontractors' and Suppliers' (when at the Site) compliance with Contractor's work schedule submitted to Engineer.
3. In the event of changes, submit to Engineer revised work schedule. Furnish such Submittal not less than 7 days prior to changing Contractor's work schedule, except in event of unanticipated emergency.

D. Preliminary Progress Schedule:

1. Within 15 days after the Contract Times commence running, Contractor shall submit to Engineer the preliminary Progress Schedule covering the entire Project, with associated schedule-related Submittals required in this Section's "Submittals" Article.
2. Submit preliminary Progress Schedule in accordance with Section 01 31 26 - Electronic Communication Protocols and Section 01 33 00 - Submittal Procedures. Also submit preliminary Progress Schedule in its native (executable) format generated by the scheduling software, transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols.
3. Engineer will perform timely review of the preliminary Progress Schedule.
4. Preliminary Progress Schedule shall comply with the Contract Documents relative to Progress Schedules.

E. Initial Acceptance of Progress Schedule:

1. Not less than 10 days before submission of the first Application for Payment, a scheduling conference attended by Contractor, Progress Schedule preparer, Engineer, and others as appropriate will be held at the Site to review for acceptability to Engineer the preliminary Progress Schedule and associated schedule-related Submittals. Following the scheduling conference, Contractor shall have five days to make corrections and adjustments and to complete and resubmit the Progress Schedule and associated schedule-related Submittals. Contractor will not be eligible for first progress payment until acceptable Progress Schedule and associated schedule-related Submittals are submitted to Engineer and are acceptable to Engineer.
2. Submit acceptable Progress Schedule, together with associated schedule-related Submittals in accordance with this Section's "Submittals" Article, Section 01 31 26 – Electronic Communication Protocols, and Section 01 33 00 - Submittal Procedures. Also submit acceptable form of Progress Schedule in its native (executable) format generated by the scheduling software, transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols.
3. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times, in accordance with the Contract Documents.
4. Initially-accepted Progress Schedule shall be identified as the baseline Progress Schedule.

F. Planned Completion Different from the Contract Times:

1. If the Progress Schedule accepted by Engineer indicates completion date(s) different than the Contract Times, the Contract Times are not thereby changed.
2. Where the Progress Schedule accepted by Engineer indicates date(s) by which the Work, or designated portion thereof, will (a) achieve a Contractually stipulated Milestone, or (b) be substantially complete, or (c) all the Work will be complete and ready for final payment, earlier than the Contract Times ("early completion date"), Contractor shall, not less than 180 days prior to the associated Contract Time, prepare and submit a Change Proposal setting forth Contractor's request to modify the Contract Times to an earlier date, which may or may not be the same as the scheduled early completion date. The Contract Times can be modified only via a Change Order.
3. In the event the Progress Schedule accepted by Engineer indicates one or more early completion dates and the Contract Times have not been reduced, Owner may, at Owner's option, use available float without Owner being liable for Contractor's costs to remain onsite, mobilized, and working (whether on the original scope of the Work or for modified Work) beyond the scheduled early completion date(s), as long as the Work will be completed within the Contract Times.
4. When the Work will not be completed within the Contract Times, the Contract Documents' provisions concerning delays and changes in the Contract Times govern.

1.7 LOOK-AHEAD SCHEDULES

A. Look-Ahead Schedules – General:

1. Look-ahead schedules are short-duration, often more-detailed, time-based schedules for the Work to be performed during the coming month or other required span of the look-ahead schedule.
2. Purpose of look-ahead schedules is to present , for Project stakeholders, including Owner, facility manager (if other than Owner), Engineer, Owner-hired testing and inspection entities, other contractors working at or adjacent to the Site, utility owners, transportation facility owners, and others as necessary, Contractor's detailed, time-based plan for performing the Work during the period covered by the timespan of the look-ahead schedule.
3. This Section's "Submittals" Article indicates the required span and frequency of look-ahead schedules..
4. Each look-ahead schedule shall be fully coordinated and consistent with the current Progress Schedule update.
5. Submit look-ahead schedules concurrent with construction progress meetings, in accordance with Section 01 31 26 - Electronic Communication Protocols, and Section 01 33 00 - Submittal Procedures. Also submit look-ahead schedules in native (executable) format, in accordance with Section 01 31 26 - Electronic Communication Protocols.
6. As handouts, bring to each construction progress meeting the quantity of paper copies of the new look-ahead schedule indicated in Section 01 31 19 - Project Meetings. If quantity is not indicated in Section 01 31 19 - Project Meetings, furnish quantity equal to typical number of attendees of progress meetings.

B. Organization and Content of Look-Ahead Schedules:

1. Look-ahead schedules shall be prepared from the current Progress Schedule update, of the same type, using the same software, content, and organization required in this Section for initial Progress Schedules.
2. Activity designations on look-ahead schedules shall incorporate the associated activity designations from the Progress Schedule.
3. Sheet Size: Format look-ahead schedules to sheet size of 11 inches by 17 inches, unless other sheet size is acceptable to Engineer.
4. Look-ahead schedules should generally be more-detailed than the Progress Schedule. Activity durations on look-ahead schedules should not exceed five days.

1.8 PROGRESS SCHEDULE UPDATES

A. Updates – General:

1. Update the Progress Schedule not less-often than once per month. If during progress of the Work events develop that necessitate changes in the initially accepted Progress Schedule (baseline Progress Schedule), identify updated Progress Schedules sequentially as "Progress Schedule Revision "1", "2", "3", and continuing in sequence as required. Number the Progress Schedule submittals in accordance with Section 01 33 00 - Submittal Procedures.
2. Progress Schedule updates shall comply with this Section's requirements for initial progress Schedule, relative to type, required software, organization, content, and related matters.
3. Starting with first Progress Schedule update, and continuing with each subsequent update, indicate on the Progress Schedule the actual start and finish dates of each activity that is completed or is currently underway. Inaccurate representation of completed or in-progress activities will be grounds for Engineer's non-acceptance of the Progress Schedule update.
4. Contractor's Progress Schedule update shall include a narrative report in accordance with this Section. Narrative report shall include description of: progress achieved to date and status of each work area of the Project, planned progress for the upcoming period, identification of the critical path, current or potential delays, Change Orders (pending and approved since the previous Progress Schedule update), and other problems associated with performing the Work in accordance with the baseline Progress Schedule and complying with the Contract Documents, including the Contract Times. Indicate in the narrative report delays that have occurred since the previous updated Progress Schedule.

5. The update to the Progress Schedule shall be based on retained logic. Progress override logic is not allowed.
6. Submit to Engineer updated Progress Schedule, together with associated schedule-related Submittals, in accordance with this Section's "Submittals" Article, Section 01 31 26 - Electronic Communication Protocols, and Section 01 33 00 - Submittal Procedures. Also submit updated Progress Schedule in its native (executable) format generated by the scheduling software, transmitted in accordance with Section 01 31 26 - Electronic Communication Protocols.

B. Monthly Schedule Meeting:

1. During the month, utilizing the previous month's look-ahead schedule. Contractor shall record the percent complete, start and finish dates of each scheduled activity with the remaining duration for each activity started but not completed, including activities associated with procurement of materials and equipment.
2. On the same day each month, not less than one week prior to a progress meeting, Contractor, Progress Schedule preparer, Engineer (or Resident Project Representative), and others as appropriate shall meet at the Site to tour the Work to review and recommend updates to the Progress Schedule and progress information gathered by Contractor during the month. After discussion of Contractor's current progress information and attendees' review of the current status of the Work, Progress Schedule preparer shall appropriately and accurately update the Progress Schedule.

1.9 NARRATIVE REPORTS

A. Narrative Reports – General:

1. Prepare and include with the preliminary Progress Schedule Submittal and each subsequent Progress Schedule Submittal, written narrative report describing the schedule-related constraints required by the Contract Documents and Contractor's plan and schedule for complying with such requirements. Narrative reports shall also include required content indicated above in this Section's "Progress Schedule Updates" Article.
2. Narrative report shall describe the methods of sequencing and operation, resources to be employed, time frames for the construction of each of the major work area or work system on the Project, and time frames for complying with the Contract Times and Contractor's interim schedule milestones.
3. Prepare narrative reports on Contractor's company letterhead and clearly indicate the Progress Schedule revision and date associated with the narrative report.
4. Narrative reports shall be written in English and typed. Use clear, concise, complete, and accurate language in narrative reports. Clearly indicate in narrative report the name of person preparing the narrative report and date of preparation
5. Narrative report Submittals do not constitute contractual Change Proposals, nor are they notice of a Claim.
6. Engineer's receipt, review, and acceptance of narrative reports does not mitigate or reduce Contractor's obligations to furnish contractually required notices.

1.10 TIME IMPACT ANALYSIS

A. Time Impact Analyses – General:

1. Prepare and submit time impact analysis when one or more of the following occurs: (a) Change Proposal is prepared; (b) Work Change Directive is issued that will affect the Progress Schedule; or (c) when delays occur.
2. Time impact analysis shall illustrate influence of each Change Order, Work Change Directive, allowance authorization, or delay, as applicable, on Contractor's ability to comply with the Contract Times and Progress Schedule constraints.
3. In performing time impact analysis, use Progress Schedule having revision date closest to and prior to the event giving rise to the delay or other change in the Work.

4. Indicate in time impact analysis activities on the Project's critical path prior to the event giving rise to the delay or other Change in the Work; activities added, extended, or deleted as a result of the delay or change in the Work; and impact of such changes on the Project's critical path activities.
5. Indicate in time impact analysis activities not within Contractor's control.
6. Time impact analysis shall demonstrate the time impact, based on date the Change Order, Work Change Directive, or allowance authorization was given to Contractor or, as applicable, date the delay started to occur; the status of the Work at that time; and activity duration of affected activities. Activity duration used in time impact analysis shall be those included in most recent Progress Schedule update accepted by Engineer, closest to start of the delay or start of the Change Order, Work Change Directive, or allowance authorization as adjusted by mutual, written agreement of the parties and Engineer.
7. Timing of Time Impact Analysis:
   a. When time impact analysis is not part of a Change Proposal, submit each time impact analysis within 15 days after the following, as applicable:
      1) Start of the delay.
      2) After Contractor's receipt of Work Change Directive.
   b. When Contractor does not submit time impact analysis for a specific change or delay, within the specified period for such submittal, such non-submittal will indicate extension of the Contract Times is not needed.

B. Evaluation by Engineer and Acceptance:

1. Engineer's evaluation of each time impact analysis comprised of complete information will be completed in timely manner (in accordance with the Contract Documents) after Engineer's receipt.
2. When time impact analysis is incomplete or otherwise inappropriate, Engineer will furnish comments to Contractor. When time impact analysis is complete and apparently appropriate, its acceptability will be indicated by associated Contract modification or allowance authorization.
3. Changes in the Contract Times will be made only by Change Order.
4. When mutual agreement is reached between the parties on effect of the change or delay in the Project, incorporate into the next Progress Schedule update the associated fragnets illustrating the influence of changes and delays.

1.11 RECOVERY SCHEDULES

A. Recovery Schedules – General:

1. When updated Progress Schedule indicates the ability to comply with the Contract Times falls 14 days or more behind schedule, and there is no excusable delay, Change Order, or Work Change Directive to support an extension of the Contract Times, Contractor shall prepare and submit to Engineer Contractor's recovery schedule.
2. Recovery schedule is a Progress Schedule demonstrating Contractor's plan to accelerate the Work to achieve compliance with the Contract Times. If achieving the Contract Times is not feasible, Contractor's recovery schedule shall indicate Contractor's plan to recover as much of the lost time as possible to complete the Work as close as possible to the Contract Times.
3. Submit recovery schedule within 10 days after submittal of updated Progress Schedule where need for recovery schedule is indicated.

B. Recovery Schedule Report:

1. With each recovery schedule Submittal, include recovery schedule narrative report, manually prepared by Contractor, on Contractor's company letterhead, indicating name of person responsible for preparing the recovery schedule and report.
2. Recovery schedule report shall verbally indicate Contractor's plan for accelerating the Work and recovering lost time, and shall indicate the total number of days expected to be

recovered by Contractor's implementation of the recovery schedule. Clearly indicate how the intended actions will recover lost time.

3. Contractor is fully responsible for complying with the Contract Documents, including the contract Times.

C. Implementation of Recovery Schedule:

1. At no additional cost to Owner, do one or more of the following, as appropriate: (a) furnish additional labor, (b) provide additional construction equipment and machinery, (c) provide suitable materials to accelerate the Work, (d) employ additional work shifts, (e) expedite procurement of materials and equipment to be incorporated into the Work or otherwise expedite delivery of such items, (f) provide other needed resources, and (g) provide other measures necessary to complete the Work within the Contract Times.
2. Upon acceptance of recovery schedule by Engineer, incorporate recovery schedule into the next Progress Schedule update.

D. Contractor's Failure to Recover Lost Time:

1. Contractor's refusal, failure, or neglect to take appropriate measures to recover lost time, or to submit a recovery schedule, shall constitute reasonable evidence that Contractor is not prosecuting the Work, or designated part of the Work, with diligence to ensure completion in accordance with the Contract Times. Such action or inaction by Contractor shall constitute sufficient basis for Owner to exercise remedies available to Owner under the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Definition of various types of Submittals.
2. Coordination requirements for Submittals.
3. General provisions concerning Submittals.
4. Schedule of Submittals.
5. Contractor's preparation of Submittals, including:
   a. Numbering.
   b. Marking.
   c. Organization and content.
   d. Proposed "or-equals", substitutes, and deviations from Contract requirements.
   e. Electronic Documents Submittals.
   f. Contractor's review and approval of each Submittal.
   g. Resubmittals.
6. Contractor's transmittal of Submittals, including transmittal letters, transmittal and delivery method, and delivery of Samples, Closeout Submittals, and Maintenance Materials Submittals.
7. Engineer's review, including:
   a. Timing.
   b. Meaning of Engineer's Submittal action code(disposition) assigned.
   c. Delivery of Engineer's responses on Submittals.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, services, incidentals, and other effort necessary to furnish Shop Drawings, product data Submittals, Samples, and other Submittals in accordance with the Contract Documents.
2. This Section's Article, "General Provisions Concerning Submittals" includes a summary of the Contract Documents' locations of Submittals requirements.
3. Shop Drawings, product data Submittals, Samples, and other Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Engineer's approval or acceptance, as applicable, of a Submittal does not alter or modify the Contract Documents.
4. Engineer and Owner have the right to rely on Contractor's representations and certifications made regarding each Submittal.

C. Related Requirements: Include but are not limited to:

1. Section 01 25 00 - Substitution Procedures.
2. Section 01 31 26 - Electronic Communication Protocols.
3. Section 01 32 16 - Construction Progress Schedule.
4. Section 01 78 23 - Operations and Maintenance Manuals.

1.2 REFERENCES

A. References – Introduction:

1. This Article presents definitions and terminology used in this Section and throughout the Contract Documents.
2. Applicability of the Term “Submittals”: Where reference is made to Shop Drawings, product data Submittals, Samples, or other Submittals in this Section and elsewhere in the Contract Documents, the term “Submittals”, as defined in the Contract Documents, is intended. The foregoing applies regardless of whether such term is indicated with an initial capital letter, unless context of the subject provision clearly indicates otherwise.
3. Types of Submittals:
   a. Submittal types are classified as follows: (1) Action Submittals, (2) Informational Submittals, (3) Closeout Submittals, and (4) Maintenance Materials Submittals.
   b. Type of each required Submittal is indicated in the associated Specifications section. When Submittal type is not clearly indicated in the associated Specifications section, Submittal will be classified as indicated in this Article. Submit request for interpretation when Contractor is uncertain of required Submittal type.

B. Action Submittals:

1. Action Submittals require an explicit, written approval or other appropriate action by Engineer (or other entity to whom the Submittal is required to be furnished, in accordance with the Contract Documents) before Contractor may release the associated item(s) for raw materials procurement, fabrication, production, and shipping.
2. Unless otherwise indicated in the Contract Documents, Action Submittals include the following:
   a. Shop Drawings.
   b. Product data.
   c. Samples.
   d. Testing plans for quality control activities required by the Contract Documents.
   e. Delegated Designs: Delegated design professional’s “instruments of service” Submittals required by the Contract Documents , as further described in Section 01 35 73 – Delegated Design Procedures.
3. General Conditions’ requirements for Shop Drawings and Samples hereby apply to all Action Submittals.

C. Informational Submittals:

1. Informational Submittals are so indicated in the Contract Documents. Unless otherwise indicated, Informational Submittals include certifications, evaluation reports, results of source quality control activities, results of field quality control activities, Supplier instructions, reports of Suppliers’ visits to the Site, sustainable design Submittals (that are not Closeout Submittals), delegated design Submittals that are not “instruments of service” Submittals, qualifications statements, and others.
2. Informational Submittals, when submitted in accordance with the Contract and indicating full compliance with the Contract Documents, do not require explicit response from Engineer (or other entity to whom the Submittal is to be delivered); Engineer’s (or other entity’s) acceptance thereof will be indicated in the Engineer’s

Submittals log. Copy of Engineer's Submittals log is available to Contractor upon Contractor's written request.

3. When Informational Submittal does not indicate full compliance with the Contract Documents, Engineer (or other entity to which Submittal is to be delivered) will indicate the non-compliance in a written response to Contractor.

D. Closeout Submittals:

1. Closeout Submittals are so indicated in the Contract Documents and are, in general, required before the associated Work is completed, unless earlier submittal is required by the Contract Documents.
2. Unless indicated otherwise in the Contract Documents, Closeout Submittals include maintenance contracts, operation and maintenance data, warranties, bonds (other than performance and payment bonds required prior to the start of construction), record documents, sustainable design closeout Submittals, software, keys, and others.
3. Closeout Submittals are processed in the same manner as described above for Informational Submittals.

E. Maintenance Materials Submittals:

1. Maintenance materials include spare parts, extra materials, tools, and similar items required to be furnished in accordance with the Contract Documents.
2. Furnish required physical maintenance materials, delivered to Owner or facility manager (if other than Owner), as applicable, at the location(s) indicated in the Contract Documents, for the corresponding required Maintenance Materials Submittals.
3. Maintenance Materials Submittals are documentation of delivery to Owner's or facility manager, and their acceptance of, required physical maintenance materials.
4. Maintenance Materials Submittals are processed in the same manner as described above for Informational Submittals.

F. Additional Terms:

1. The following terms have the meanings indicated below, regardless of whether such terms are indicated using initial capital letters, and apply to singular and plural of each:
   a. "Product data" means illustrations, standard schedules, performance charts, Supplier's published instructions, brochures, diagrams, and other information furnished by Contractor to illustrate or describe materials or equipment for some portion of the Work. In general, product data are manufacturers' pre-published information on the items proposed to be incorporated into the Work. Product data includes manufacturer's catalog pages and similar documents with contractor-made markings and indications of proposed products and proposed options.
   b. The term "Shop Drawings", defined in the General Conditions, is supplemented by the following: Shop Drawings include: (1) fabrication and assembly drawings, usually having a title block, or (2) schedules, prepared specifically for the Project. Here, "schedules" means a Project-specific summary of systems and components, such as a schedule of HVAC equipment, schedules of doors and door hardware, or windows, or a schedule of paint systems by room and surface, or other, similar Project information in a tabular format. In contrast, construction Progress Schedules, Schedules of Submittals, and Schedules of Values are not Shop Drawings. Unless expressly required otherwise in the

Contract Documents, Shop Drawings shall not be prepared from, or on, the Drawings or any other component of the Contract Documents.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Furnish Submittals well in advance of need for the associated material or equipment, or procedure (as applicable), in the Work and with ample time necessary for delivery of materials and equipment and to implement procedures following Engineer's approval or acceptance of the associated Submittal.
2. Work covered by a Submittal will not be included in payments by Owner until approval or acceptance (as applicable) of related Submittals has been obtained in accordance with the Contract Documents.

1.4 GENERAL PROVISIONS CONCERNING SUBMITTALS

A. Locations of Requirements:

1. Requirements concerning Submittals are generally located as follows:
   a. General Conditions, as may be modified by the Supplementary Conditions, applicable to the Project.
   b. This Section, which presents general requirements for Submittals applicable to the Project.
   c. Other Division 01 Specifications that include general requirements for certain types of Submittals, such as Section 01 31 26 - Electronic Communications Protocols, Section 01 78 23 - Operation and Maintenance Data, Section 01 35 73 - Delegated Design Procedures (when the Contract includes delegation of professional design services), and others.
   d. The "Submittals" Article of the various Specifications sections, which indicates the required Submittals for the associated Work. Furnish all Submittals required by the Contract Documents regardless of whether explicitly indicated in the associated Specifications' "Submittals" Article.

B. This Section augments and supplements the requirements of the General Conditions, as may be modified by the Supplementary Conditions, relative to Submittals.

1.5 SCHEDULE OF SUBMITTALS

A. Draft Submittal List: A Draft Submittal List has been provided as Attachment A to this section. This list is not all-inclusive. It is the Contractor's responsibility to identify and develop an all-inclusive schedule of submittals as described in this Section. Omitting a submittal in the schedule of submittals does not exempt the Contractor from the requirement to provide a submittal listed in the contract documents. Additional requirements for the submittals can be found in the individual Sections of the contract documents.

B. Informational Submittals: Submit the following:

1. Schedule of Submittals:
   a. Timing:
      1) Furnish Schedule of Submittals within time frames indicated in the General Conditions, as may be modified by the Supplementary Conditions.
      2) Submit updated Schedule of Submittals with each submittal of the updated Progress Schedule.
   b. Content: In accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section. Requirements for content of

preliminary Schedule of Submittals and subsequent Submittals of the Schedule of Submittals are identical. Identify on Schedule of Submittals all Submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Clearly indicate Submittals that are on the Project's critical path. Indicate the following for each Submittal:

1) Date by which Submittal will be received by Engineer.
2) Whether Submittal will be for a substitution or "or-equal".
3) Date by which Engineer's response is required. Allow not less than 14 days for Engineer's review, starting on Engineer's actual receipt of each Submittal. Allow increased time for large or complex Submittals.
4) For Submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of others (if any).

c. Coordinate Schedule of Submittals with the Progress Schedule.

d. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate Submittals on the Project's critical path, or that places extraordinary demands on Engineer for time and resources, is unacceptable. Do not include Submittals not required by the Contract Documents.

e. In preparing Schedule of Submittals:

1) Considering the long-lead times for electrical, controls, electro-mechanical and process mechanical equipment, prioritize long-lead item submittals ahead of readily available materials and equipment. Examples of long-lead equipment include service switchboards, master control panels, pumps.
2) Considering the nature and complexity of each Submittal, allow sufficient time for reviews and revisions.
3) Allow reasonable time for: Engineer's review and processing of Submittals, for Submittals to be revised and resubmitted, and for returning Submittals to Contractor.
4) Identify and accordingly schedule Submittals that are expected to have long anticipated review times.

1.6 PREPARATION OF SUBMITTALS

A. Prior to Submittal Preparation:

1. The General Conditions, as may be modified by the Supplementary Conditions, address Contractor's responsibility for submitting for Owner's acceptance identification of Subcontractors and Suppliers. Obtain Owner's acceptance before entering into subcontracts and purchase orders for the Work.
2. Comply with the Contract Documents relative to terms and conditions of subcontracts and purchase orders for the Work.
3. Contractor's responsibilities for the following are set forth in the General Conditions, as may be modified by the Supplementary Conditions, and as may be augmented elsewhere in the Contract Documents:

a. Obtaining field measurements and dimensions.

b. Determining and verifying required quantities.

c. Verifying compatibility of materials.

d. Apportioning the Work among Subcontractors, Suppliers, and Contractor.

e. Reconciling required materials, equipment, and other Contract requirements with Contractor's means, methods, techniques, sequences, and procedures of

construction and with Contractor's safety and protection programs and precautions incident thereto.

f. Reviewing applicable provisions of the Contract Documents and obtaining from Engineer necessary interpretations or clarifications.

B. Submittal Identification:

1. Submittal Number: Shall be a unique number assigned to each individual Submittal. Assign Submittal numbers as follows:

a. First part of Submittal number shall be the applicable Specifications section number, followed by a hyphen.

b. Second part of Submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate Submittal furnished under the associated Specifications section.

c. Example: Submittal number for the third Submittal furnished for Section 10 14 00 - Signage, would be "10 14 00-003".

2. Review Cycle Number: Each resubmittal of a given Submittal shall be indicated with a lower-case letter designation:

a. No letter designation for initial (first) submittal of the Submittal number.

b. "a" shall indicate first resubmittal of the Submittal number.

c. "b" shall indicate second resubmittal of the Submittal number.

3. Examples:

Example Description	Submittal Identification	
	Submittal No.	**Review Cycle**
Initial (first) review cycle of the third Submittal furnished under Section 10 14 23 – Signage	10 14 00-003-	
Second review cycle (first resubmittal) of third Submittal furnished under Section 10 14 23 - Signage	10 14 00-003-	a

C. Marking of Submittals:

1. Mark on each page of each Submittal and each individual component submitted with Submittal number and applicable Specifications paragraph.

2. Mark each page of each Submittal with the Submittal page number.

3. Each Shop Drawing sheet shall have title block with complete identifying information satisfactory to Engineer.

4. For product data Submittals, operation and maintenance data Submittals, and other Submittals:

a. Mark options to be furnished using broad, dark arrows or "clouds" clearly drawn around the relevant text or diagrams. Do not use highlighter for indicating options and features.

b. Indicate options and features not furnished using clear strikeouts through the text or diagrams.

D. Submittal Organization and Content – General:

1. Page or Sheet Size; Furnish Submittals with one or more of the following page or sheet sizes: (a) 8.5 inches by 11 inches; (b) 11 inches by 17 inches; (c) 22 inches by 34 inches; unless another sheet size is acceptable to Engineer.

2. Language: All parts of each Submittal shall be in the English language.
3. Units of Measurement: Clearly indicate units of measurement on Shop Drawings, product data Submittals, record documentation, and operation and maintenance data Submittals.
4. Organize each Submittal logically to facilitate ease of understanding and review.
5. To the extent practicable, arrange Submittal information in same order as requirements are written in the associated Specifications section.
6. Each Submittal shall cover Work under only one Specifications section.
7. To the extent practicable, package together Submittals for the same Specifications section. Do not furnish required information piecemeal.
8. For large or complex Submittals, include a title page and table of contents.
9. Include appropriately labeled fly sheets to separate distinct parts of each Submittal.
10. Ensure legibility of all pages in each Submittal.
11. Minimize extraneous and unnecessary information in Submittals for materials and equipment. Do not submit information not relevant to the Submittal and associated requirements of the Contract Documents.
12. Contractor's, Subcontractor's, and Supplier's written comments on Shop Drawings and product data diagrams shall be colored green
13. Do not submit under Specifications sections with title that include "Basic Requirements", unless the subject material or equipment is specified, in total, in a Specifications section with the words, "Basic Requirements" in its title.

E. Electronic Documents Submittals:

1. Format: Electronic Documents Submittals shall be "portable document format" (.PDF) files unless expressly required otherwise by applicable provisions of the Contract Documents.
2. Electronic Documents Submittals must be electronically searchable when delivered to Engineer and other recipients.
3. Organization and Content:
   a. Each Electronic Documents Submittal shall be one file; do not divide individual Submittals into multiple Electronic Documents files each unless file size will exceed 20 MB.
   b. When Submittal is large or contains multiple parts, furnish PDF file with suitably titled electronic bookmark for each section of the Submittal.
   c. Content shall be identical to paper or other original Submittal. First page of each Electronic Documents Submittal shall be transmittal letter required in this's Paragraph 1.7.A.
4. Quality and Legibility: Electronic Documents Submittal files shall be made from the original and shall be clear and legible. Markings applied by Contractor, Subcontractor, or Supplier shall be clear, distinct, and readily apparent. Electronic Documents file shall be full size of original documents. Properly orient all pages for convenient reading on a computer display; do not furnish pages sideways or upside-down..
5. Provide sufficient internet service, software, and systems for Contractor with capability appropriate for transmitting the necessary files and receiving responses from Engineer or other entities.
6. Check not less than once per day for distribution of Electronic Documents Submittals responses and related Electronic Documents correspondence.

F. Proposed "Or-Equals", Substitutes, and Deviations from Contract Requirements:

1. “Or-Equals”:
    a. The meaning of “or-equal” is addressed in Section 01 25 00 - Substitution Procedures.
    b. Contractor’s request for approval of “or-equals” is to be presented via the associated Action Submittal(s) and shall include the information required in provisions governing “or-equals” in Section 01 62 00 - Product Options.
    c. Expressly and prominently indicate, “Proposed Or-Equal” on the associated Action Submittals when Submittal is for an “or-equal”.
    d. Submittals requesting approval of an “or-equal” but not accompanied by the required, supplemental information will be deemed incomplete by Engineer and returned to Contractor without approval.
2. Substitutes:
    a. The meaning of “substitute” is indicated in Section 01 25 00 - Substitution Procedures.
    b. Requests for approval of substitutes shall comply with Section 01 25 00 - Substitution procedures, and other relevant provisions of the Contract Documents.
    c. Contractor’s request for approval of substitute is separate from the associated Action Submittal(s). Action Submittals that request approval of a substitute when a separate, formal substitution request (furnished in accordance with the Contract Documents) was not previously furnished to Engineer, followed by formal approval in via an appropriate contract modification (typically either a Field Order or Change Order), will be deemed by Engineer as non-compliant with the Contract Documents and will be returned to Contractor without approval.
    d. Contractor is solely responsible for delays incurred due to substitutes proposed via Submittals that have not been previously duly approved via an appropriate Contract modification.
    e. Action Submittals for items or procedures approved via an appropriate Contract modification shall include a copy of the Contract modification in which the substitute was approved.
3. Submittals with Proposed Deviations from Contract Requirements:
    a. When Submittal proposes deviations from requirements of the Contract Documents, the Submittal shall clearly and expressly indicate each proposed deviation.
    b. Also comply with this Section’s provision, in the Article below, on Contractor’s transmittal letter expressly alerting Engineer to the proposed deviations.
    c. Comply with requirements of the Contract regarding substitutes and “or-equals”.
    d. When deviation is proposed, also appropriately revise text of Contractor’s approval, from that required below in this Article.
    e. When Submittal includes deviations from Contract requirements and either the Submittal itself, Contractor’s transmittal letter, or both, do not comply fully with Contract requirements for indicating deviations in Submittals and giving separate written notice thereof, Engineer’s approval of such deviations will be deemed null and void unless Engineer’s written response to the Submittal has expressly acknowledged such deviation and indicated Engineer’s approval thereof.
    f. Contractor is solely responsible for delays and costs incurred due to any and all Submittals with deviations from Contract requirements that were not properly,

expressly indicated and approved in accordance with the Contract Documents. Deviations not duly approved in accordance with the Contract Documents may be deemed defective Work. Contractor is solely responsible for remedying defective Work and all associated cost and time impacts.

G. Contractor's Approval of Submittals:

1. Contractor's Review: Before transmitting Submittals to Engineer, review each Submittal to:
   a. Ensure proper coordination of the Work.
   b. Determine that each Submittal is in accordance with Contractor's desires.
   c. Verify that Submittal contains sufficient information for Engineer to determine compliance with the Contract Documents.
2. Incomplete or inadequate Submittals will be returned without detailed review by Engineer.
3. Contractor's Approval Stamp and Signature:
   a. Each Submittal furnished shall bear Contractor's approval stamp (or facsimile thereof) and signature, as evidence that the Submittal has been reviewed and approved by Contractor and verified as complete and in accordance with the Contract Documents.
   b. Submittals without Contractor's approval and signature (as required by the contract Documents) will be returned to Contractor without further review by Engineer and deemed incomplete.
   c. Engineer reserves the right to reject as incomplete Submittals where Contractor's approval signature appears computer-generated or reproduced without the active involvement or review of Contractor's signatory.
   d. Contractor's approval shall contain the following text:

Project Name: _____
Contractor's Name: _____
Contract Designation: _____
Date: _____

---------- *Reference* ----------

Submittal Title: _____
Specifications:
Section: _____
Page No.: _____
Paragraph No.: _____
Drawing No.: _____of _____
Location of Work: _____

Submittal No. and Review Cycle: _____
Coordinated by Contractor with Submittal Nos.: _____
_____

I hereby certify that Contractor has satisfied Contractor's obligations under the Contract Documents relative to Contractor's review and approval of this Submittal, including: (1) reviewed and coordinated the Submittal with other Submittals and with the requirements of the Work and the Contract Documents; (2) determined and verified all: field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with

respect to the Submittal, (b) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work, and (c) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto; (3) confirmed the Submittal is complete with respect to all related data included in the Submittal; and (4) clearly and expressly indicated all proposed deviations (if any) from the requirements of the Contract Documents both in the Submittal itself and in the Submittal's transmittal letter. Accordingly, this Submittal is hereby approved for Contractor by:

Approved for Contractor by: _____

H. Resubmittals:

1. Refer to the General Conditions, as may be modified by the Supplementary Conditions, for requirements regarding resubmitting required Submittals.
2. In addition to limits on the quantity of resubmittals, as indicated in the General Conditions, Contractor shall furnish Submittals with such completeness, accuracy, and compliance with the Contract Documents to obtain Engineer's approval or acceptance, as applicable, without the total quantity of Submittals furnished, including all initial Submittals and all resubmittals, exceeding 125 % of the number of Submittals indicated on the Schedule of Submittals initially accepted by Engineer, plus a corresponding percentage of the quantity of Submittals required by Change Orders, Work Change Directives, and Field Orders.
3. Do not increase the scope of prior review cycle of the same Submittal.
4. Indicate on Contractor's transmittal letter how Submittal was revised from previous review cycle of the Submittal and where the revisions or corrections are located within the resubmittal.
5. Expressly address and provide response for all components previously transmitted by Engineer on prior review cycles of the subject Submittal. Where resubmittal lacks complete response to Engineer's prior comments, Engineer may deem such resubmittal as incomplete and return it to Contractor without further review.
6. Where part of the Submittal's prior review cycle was expressly approved or accepted, as applicable, by Engineer, do not include such items in subsequent resubmittals.
7. Indicate, "Not Yet Resolved—To Be Resubmitted at a Later Date" for any items not approved in prior review cycle of the Submittal for items not included in the subject resubmittal. Engineer reserves the right to deem incomplete Submittals "Not Approved" or "Revise and Resubmit". Furnishing incomplete or partial resubmittals is discouraged.
8. Resubmittal of Previously Approved or Accepted Items:
   a. Do not resubmit on a given item previously approved or accepted, as applicable, by Engineer, without Engineer's advance consent. Consent will be given for bona-fide unavailability of a previously approved or accepted item where Contractor has acted in good faith in a timely manner with due diligence to comply with the Contract Times.
   b. Destroy or conspicuously mark "SUPERSEDED" on all documents having previously received Engineer's approval or acceptance, as applicable, that are superseded by a resubmittal.

1.7 TRANSMITTAL OF SUBMITTALS BY CONTRACTOR

A. Contractor's Transmittal Letters for Submittals:

1. Furnish separate transmittal letter with each Submittal. Use transmittal form attached to this Section (as Exhibit 01 33 00-A) unless other transmittal form is acceptable to Engineer at the start of the Project's construction.
2. When transmittal form other than this Section's Exhibit 01 33 00-A is acceptable to Engineer, at beginning of each transmittal, include a reference heading indicating: Contractor's name, Owner's name, Project designation, Contract designation, transmittal number, and Submittal number (with review cycle).
3. "Or-Equals": When the Submittal is proposing an "or-equal", expressly so indicate on transmittal form submitted by Contractor.
4. Proposed Deviations from Contract Requirements: When the Submittal proposes deviations from requirements of the Contract Documents, transmittal letter shall specifically describe each proposed deviation.

B. Submittal Delivery Method:

1. This provision presents general requirements for delivery or all Submittals unless otherwise required elsewhere in the Contract Documents.
2. Furnish Submittals as Electronic Documents delivered in accordance with Section 01 31 26 – Electronic Communication Protocols.
3. Furnish Submittals to Engineer and each other entity indicated in the Contract Documents as receiving a Submittal directly from Contractor.
4. Address Submittals to Engineer as follows: HDR Engineering, Inc., Attn: Jerry Otto, 412 E. Parkcenter Blvd., Ste 100, Boise, Idaho 83706, jerry.otto@hdrinc.com.
5. Preliminary Copy for Field Office: Simultaneously with delivering Electronic Documents Submittal to Engineer, also deliver:
   a. Resident Project Representative.

C. Samples - Transmittal and Delivery:

1. Labeling and Tagging Samples:
   a. Securely label or tag each Sample with Submittal identification number.
   b. Label or tag shall include clear space at least 4 inches by 4 inches in size for affixing Engineer's review stamp indicating disposition assigned by Engineer.
   c. Label or tag shall not cover, conceal, or alter Sample's appearance or features.
   d. Label or tag shall not be separated from the Sample.
2. Timing: Deliver required Samples concurrently with other Action Submittals required for the same element of the Work, unless other delivery time frame is indicated in the Schedule of Submittals accepted by Engineer.
3. Quantity Required:
   a. Where the Contract Documents require a Sample as a field mock-up, provide Sample at the Site or in the Work at location acceptable to Engineer. Provide the quantity of field mock-ups required by the contract Documents; if not otherwise shown or specified, provide one of each required field mock-up. .
   b. For reasonably portable Samples, deliver the quantity of Samples required in the associated Specifications. If quantity of Samples is not indicated in the associated Specifications section, deliver to Engineer not less than three identical Samples of each item for which Sample is required.
   c. Samples will not be returned to Contractor. If Contractor requires Sample(s) for Contractor's use, so advise Engineer in writing and furnish additional copies of the Sample. Contractor is responsible for furnishing, shipping, and transporting additional Samples.

4. Locations for Delivery of Reasonably Portable Samples for Review:
    a. Deliver one physical Sample to Engineer and Owner's Site Representative's field office at the Site.
    b. Deliver balance of required physical Samples to Engineer at address indicated in this Article for receipt of Submittals, unless otherwise directed by Engineer.

D. Closeout Submittals –Transmittal and Delivery:

1. Furnish the following Closeout Submittals in accordance with general requirements for transmitting and delivering Submittals, indicated above in this Article: maintenance contracts; warranty bonds (when required) and other bonds required for specific materials, equipment, or systems; warranty documentation; and sustainable design closeout documentation (when required). On documents such as maintenance contracts and bonds, include on each document furnished original ("wet") signature of entity issuing said document. When original "wet" signatures are required, furnish such Submittals to Engineer both on original paper and as Electronic Documents, and to other entities furnish as indicated above in this Article for general requirements for Submittals.
2. Operations and Maintenance Manuals: Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.
3. Record Documents: Submit in accordance with Section 01 78 39 - Project Record Documents.
4. Software: In addition to software installed on Owner's computer system, furnish number of copies of software required in the Specifications section where the software is specified. Preferred means of transmittal is via secure file transfer directly to Owner (or facility manager, if other than Owner) via secure file transfer method mutually acceptable to software developer and the receiving entity. When secure file transfer is used, submit to Engineer documentation signed or electronically acknowledged by Owner that the files were received. Where such software is available only on the software developer's portable media, furnish such software on software developer's original, portable media, sealed in software developer's original, unopened, clearly labeled packaging.

E. Maintenance Materials Submittals – Delivery:

1. Deliver physical maintenance materials required by the Contract Documents in accordance with applicable provisions of the Contract.
2. Submit documentation of delivery of (Maintenance Materials Submittals) in accordance with general requirements for Submittals as indicated in this Section.

1.8 ENGINEER'S REVIEW OF SUBMITTALS

A. This Article applies to review of all Submittals by Engineer or other entity to whom the Contract Documents require such Submittal be furnished.

B. Timing:

1. Timing of Engineer's review will be in accordance with the Schedule of Submittals accepted by Engineer.
2. When Submittal is delivered to Engineer on a date other than that indicated in the Schedule of Submittals accepted by Engineer, duration of Engineer's review may differ from that indicated in the Schedule of Submittals, based on Engineer's availability and resources. Engineer will make good-faith effort to furnish responses to Submittals in a timely manner.
3. Contractor is responsible for communicating to Engineer when a Submittal is on the Project's critical path.

C. Engineer's Review:

1. Markings:

   a. Comments or responses marked directly on Submittal by Engineer (or other entity reviewing Submittal) will be colored red.

   b. Engineer may also present narrative comments on a comment sheet inserted by Engineer into the Submittal or included on Engineer's transmittal letter for the Submittal. Such comments will be in black text. When a separate comment sheet is included by Engineer, such sheet will be clearly identified as Engineer's comments.

2. Engineer's review and disposition assigned to Submittal are subject to the following:

   a. Submittal disposition is subject to: Engineer's comments on the Submittal; disclaimer language on Engineer's Submittal transmittal letter; Engineer's Submittal review stamp (when used) or equivalent (when used); and this provision.

   b. Engineer's review is only for general compatibility with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, and for general compliance with the information given in the Contract Documents.

   c. Contractor shall be solely responsible for complying with the Contract Documents, as well as with Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations. Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the work of all trades.

   d. Engineer is not responsible for resubmittals not yet furnished by Contractor or tracking Contractor's progress on resubmittals.

3. Documents not required by the Contract Documents but nonetheless furnished by Contractor as submittals will not be reviewed by Engineer.

D. Meaning of Submittal disposition Assigned by Engineer:

1. Action Submittals:

   a. "Approved" (Action Code A): Upon return of Submittal marked "Approved", order, ship, or fabricate materials and equipment included in the Submittal (pending Engineer's approval or acceptance, as applicable, of production-related qualifications statements and certifications, and required source quality control Submittals) or otherwise proceed with the Work in accordance with the Submittal and the Contract Documents.

   b. "Approved as Noted" (Action Code B): Upon return of Submittal marked "Approved as Noted", order, ship, or fabricate materials and equipment included in the Submittal (pending Engineer's approval or acceptance, as applicable, of production-related qualifications statements and certifications, and required source quality control Submittals) or otherwise proceed with the Work in accordance with the Submittal and the Contract Documents, and in accordance with Engineer's comments and notes indicated in Engineer's Submittal response

   c. "Revise and Resubmit" (Action Code C): Upon return of Submittal marked "Revise and Resubmit", make the revisions necessary and indicated and resubmit to Engineer for approval.

d. “Not Approved” (Action Code D): This disposition indicates material or equipment that cannot be approved. “Not Approved” disposition may also be applied to Submittals that are incomplete. Upon return of Submittal marked “Not Approved”, repeat initial submittal procedure utilizing approvable material or equipment, with a complete Submittal clearly indicating all information required.

2. Informational, Closeout, and Maintenance Materials Submittals:
   a. “Accepted” (Action Code F): Information included in Submittal complies with the applicable requirements of the Contract Documents and is acceptable. No further action by Contractor is required relative to such Submittal, and the Work covered by the Submittal may proceed. Materials and equipment with Submittals with this disposition may be shipped or operated, as applicable. Submittals assigned “Accepted” by Engineer (or other reviewing entity) does not indicate Engineer’s acceptance of the associated Work, which is indicated only as set forth in the General Conditions and Section 01 77 19 – Closeout Requirements.
   b. “Not Acceptable” (Action Code G): Submittal, or part thereof, does not indicate full compliance with applicable requirements of the Contract Documents and is not acceptable. Provide labor, materials, equipment, services, and incidentals necessary to properly and accurately revise Submittal and resubmit to indicate acceptability and compliance with the Contract Documents
3. Other:
   a. “Submittal Not Reviewed” (Action Code E): Documents so marked by Engineer are not required by the Contract Documents. Submittals may also be marked with this disposition when information in the document was previously reviewed and approved or accepted by Engineer, as applicable.

E. Distribution of Engineer’s Responses:

1. Unless otherwise indicated in the Contract Documents, Engineer will distribute written responses (as Electronic Documents) to Submittals to the following:
   a. Contractor.
   b. Owner.
   c. Owner’s Site Representative.
   d. Resident Project Representative.
   e. Engineer’s file.
2. Engineer’s acceptance of Informational Submittals, Closeout Submittals, and Maintenance Materials Submittals will be recorded in Engineer’s Submittal log. Copy of Engineer’s Submittals log is available from Engineer upon written request of Owner or Contractor. If no such request is received by Engineer, Engineer will distribute copy of Engineer’s Submittals log once per month (when Submittals have been received or acted on by Engineer). Engineer may distribute copy of Engineer’s Submittals log as an Electronic Document or as handout at construction progress meetings.
3. Paper copies of Engineer’s Submittal responses will not be distributed unless otherwise required by the Contract Documents or otherwise agreed to by Engineer.
4. Contractor is responsible for forwarding Engineer’s Submittals responses to Subcontractors and Suppliers as appropriate, and for coordinating the Work of all trades.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The documents listed below, following this Section's "End of Section" designation, are part of this Specifications Section:

1. "Exhibit 01 33 00 – Draft Submittal List
2. "Exhibit 01 33 00-B – Transmittal for Submittal No. _____" (one page).

END OF SECTION

Exhibit A – Submittal Register (Draft Submittal List)

SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
01 14 16	COORDINATION WITH OWNER'S OPERATIONS	1.4. SUBMITTALS	1.4.A. Informational Submittals: Submit the following:	Shutdown Planning Submittal
				Shutdown Notification
01 29 73	SCHEDULE OF VALUES	1.4. SUBMITTALS	1.4.A. Informational Submittals: Submit the following:	Submit to Engineer the Schedule of Values in the form and quantity required in Section 013300 – Submittals Procedures, and in accordance with Section 013126 - Electronic Communication Protocols.
01 32 16	CONSTRUCTION PROGRESS SCHEDULE	1.5. SUBMITTALS	1.5.A. Informational Submittals: Submit the following:	Qualifications Statements
				Planned Work Schedule
				Progress Schedule
				Look-Ahead Schedules
				Progress Schedule Updates
				Time Impact Analyses: Submit in accordance with this Section.
				Recovery Schedules: Submit in accordance with this Section.
01 52 11	ENGINEER'S FIELD OFFICE	1.3. SUBMITTALS	1.3.A. Action Submittals: Obtain Engineer's approval of the following prior to installing Engineer's field office at the Site and prior to obtaining furniture, furnishings, and equipment required by this	Field Office Submittal
01 57 05	TEMPORARY CONTROLS	1.3. SUBMITTALS	1.3.A. Action Submittals:	Shop Drawings Product Data
01 57 05	TEMPORARY CONTROLS		1.3.B. Informational Submittals:	Procedural Submittals Field Quality Control
01 57 20	ENVIRONMENTAL PROTECTION	1.4. SUBMITTALS	1.5.A. 01 57 20-1, Spread of Noxious Weed Prevention	Description of methods used to prevent the spread of noxious weeds, including the location of inspection and washout station.
01 61 03	EQUIPMENT - BASIC REQUIREMENTS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	For all equipment: Data sheets that include manufacturer's name and complete product model number.
				Acknowledgement that products submitted comply with the requirements of the standards referenced.
				Manufacturer's delivery, storage, handling, and installation instructions.
				Equipment identification utilizing numbering system and name utilized in Drawings.
				Equipment installation details:
				Equipment area classification rating.
				Shipping and operating weight.
				Equipment physical characteristics:
				Equipment factory primer and paint data.
				Manufacturer's recommended spare parts list.
				Equipment lining and coatings.
				Equipment utility requirements include air, natural gas, electricity, and water.
				Ladders and platforms provided with equipment:
				Operating characteristics:
				Mechanical and process equipment: Operating characteristics, Piping and duct connection size, type and location, Equipment bearing life certification, Equipment Foundation Data
				Electric motor: Motor manufacturer and model number.
				Complete motor nameplate data.
				Weight.
				NEMA design type.
				Enclosure type.
				Frame size.
				Winding insulation class and temperature rise.
				Starts per hour.
				Performance data
				Bearing data and lubrication system.
				Natural frequency calculations
				Thermal protection system including recommended alarm and trip settings for winding and bearing RTD's.
				Fabrication and/or layout drawings
				Certifications
				Electrical gear
				Systems schematics and data: Provide system schematics where required in system specifications.
				For factory painted equipment, provide paint submittals in accordance with Section 09 96 00.
				Qualifications for: Natural frequency analysis firm and personnel.
				Vibration testing firm and personnel.
				Infrared thermography testing firm and personnel.
				Electrical equipment and connections testing firm and personnel.
				Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section
				Natural frequency analysis and calculations.
				Vibration testing.
				Thermography testing.
				Electrical equipment and connection testing.
			1.4.B. Factory Test Reports:	Natural frequency bump test reports where required for rotating equipment.
				Motor, equipment and final assembled equipment including motor.
				Submit natural frequency report(s) for approval prior to shipment.
				Equipment performance tests. As listed in individual equipment specifications.
			1.4.C. Contract Closeout Information:	Operation and Maintenance Data: See Section 017823 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
			1.4.D. Informational Submittals:	Notification, at least one week in advance, that testing will be conducted at factory.
				Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
				Submit sample Manufacturer's Field Service Report (MFSR). Report shall use manufacturer's standard report or use the form in the Exhibits and have at least the information described in this Section
01 61 03	EQUIPMENT - BASIC REQUIREMENTS	1.4. SUBMITTALS		Submit completed Manufacturer's Field Service Report (MFSR) for each piece of equipment supplied.
01 73 29	CUTTING AND PATCHING	1.2. SUBMITTALS	1.2.A. Action Submittals: Submit the following:	Cutting and Patching Request
				Recommendation Regarding Cutting and Patching
				Product Data
			1.2.B. Informational Submittals: Submit the following:	Written Notification of Cutting and Patching
				X-ray Investigations
01 75 00	CHECKOUT AND START-UP PROCEDURES	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Data collection and reporting log for each required Demonstration Period.
				Plan for Pump Testing Water Supply
			1.5.B. Informational Submittals: Submit the following:	Progress Schedules indicating dates for checkout, startup, and field quality control activates.
				Completed checkout and startup log required in Paragraph 3.2.C of this Specifications section.
				Manufacturer's installation check letters (also known as Manufacturer's Field Services Report) required in Paragraph 3.2.C of this Specifications section.
				Instrumentation Supplier's Instrumentation Installation Certificate, required in Paragraph 3.2.C of this Specifications section.
				Letter verifying completion of all pre-demonstration startup activities, required in Paragraph 3.2.C of this Specifications section.
				Report of data collected during each required Demonstration Period.
				Qualifications Statements
			1.2.A. Closeout Submittals: Submit the following:	Operation and Maintenance Data
			1.2.B. Timing of Submittals and Quantity Required:	Preliminary Operation and Maintenance Manual Submittals

Exhibit A – Submittal Register (Draft Submittal List)				
SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
				Final Operation and Maintenance Manual Submittals: Furnish final Submittal prior to Substantial Completion of the associated Work, unless submittal is required prior to an interim Milestone.
01 78 36	WARRANTIES	1.2. SUBMITTALS	1.2.A. General:	For each item of equipment furnished under the Contract, submit Supplier's standard warranty, regardless of whether such warranty or Submittal thereof is required by the associated Specifications for that item. Submit such warranties for materials where such Submittal is required in the Specifications for the material.
				For each item of material or equipment where Supplier's special (or extended) warranty is required by the Contract Documents, submit appropriate special warranty that complies with the Contract Documents.
				Supplier's warranties shall be specifically endorsed to Owner, Contractor, and the entity purchasing the item (if other than Contractor) by the entity issuing such warranty.
				Submit Suppliers' standard warranties and special warranties as Submittals in accordance with the Schedule of Submittals accepted by Engineer.
01 78 39	PROJECT RECORD DOCUMENTS	1.4. SUBMITTALS	1.4.A. Action Submittals: Submit the following:	Samples
			1.4.B. Informational Submittals: Submit the following:	Qualifications Statements
			1.4.C. Closeout Submittals: Submit the following:	Record Documentation
				Certifications
01 79 23	INSTRUCTION OF OPERATION AND MAINTENANCE PERSONNEL	1.4. SUBMITTALS	1.4.A. Action Submittals: Submit the following:	Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule Submittals in accordance with time frames specified in this Specifications section.
			1.4.B. Informational Submittals: Submit the following:	Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table 01 79 23-A and the Contract Documents. Lesson plan shall comply with requirements of this Specifications section as may be supplemented by Specifications sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during training sessions. Submit lesson plan Submittals in accordance with time frames specified in this Specifications section.
				Qualifications
				Minutes of training scheduling conference.
			1.4.C. Closeout Submittals: Submit the following:	Trainee sign-in sheets for each training session. Submit to facility manager's training coordinator with copy to Engineer.
01 81 10	WIND AND SEISMIC DESIGN CRITERIA	1.4. Submittals	1.4.A. Action Submittals: Submit the following as part of the Submittals required in Divisions 02-49 Specifications that require wind , snow, and seismic delegated designs:	Delegated Design Professional's "Instruments of Service" Submittals
			1.4.B. Informational Submittals: Submit the following as part of the Submittals required in Divisions 02-49 Specifications that require wind , snow, and seismic delegated designs:	Delegated Design Professional's Calculations
				Shop Drawings and Product Data Approved by Delegated Design Professional: The following are required but will be reviewed by Engineer only for the limited purposes indicated in Section 01 33 73 - Delegated Design Procedures
02 26 00	HAZARDOUS MATERIALS ASSESSMENT	1.4. Submittals	1.2.A. Perform construction and demolition operations, including management of subcontractors, to comply with: Applicable Federal, and local laws, orders, regulations concerning control, handling and disposal of asbestos and lead-based paint containing materials, and terms and conditions of applicable permits issued by permit issuing authority.	
02 41 00	DEMOLITION	1.4. SUBMITTALS	1.4.A. Informational Submittals: Submit the following:	Procedure Submittals
				Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Specifications Section.
				Qualifications Statements:
03 01 30	REPAIR AND REHABILITATION OF EXISTING CONSTRUCTION	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
				Samples
				Advise Engineer in writing when required mock-ups will be provided and the location proposed for each.
				Test Procedures
			1.5.B. Informational Submittals: Submit the following:	Certifications
				Test and Evaluation Reports
				Manufacturer's Instructions
				Field Quality Control Submittals
				Qualifications Statements
			1.5.C. Closeout Submittals: Submit the following:	Affidavit of compliance from joint sealant system manufacturer, certifying that sealants were installed at the Site in accordance with manufacturer's written instructions and recommendations.
03 05 05	CONCRETE TESTING AND INSPECTION	1.5. SUBMITTALS	1.5.A. Shop Drawings:	Product technical data
				Certifications
03 11 13	FORMWORK	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
03 15 19	ANCHORAGE TO CONCRETE	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Shop Drawings:
				Product Data: Submit as Action Submittals product data for anchorages to concrete fully designed by Engineer. For anchorages to concrete for which final design is by delegated design professional, submit as Informational Submittals bearing approval stamp of delegated design professional.
				Delegated Design Professional's Instruments of Service Submittals: Submit, in accordance with this Section for each anchorage to concrete for which final design is by delegated design professional:
				Samples
			1.5.B. Informational Submittals: Submit the following:	Shop Drawings and Product Data Approved by Delegated Design Professional
				Calculations by Delegated Design Professional
				Supplier's Instructions
				Field Quality Control Submittals
				Reports of Supplier's Visits to Site
				Qualifications Statements
03 21 00	REINFORCEMENT	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
				Qualifications of welding operators, welding processes and procedures.
				Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and
				Sufficient reinforcing details to permit installation of reinforcing.
				Reinforcing details in accordance with ACI SP 66 and ACI 315.
				Locations where proprietary reinforcing mechanical splices are required or proposed for use.
				Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
03 31 30	CONCRETE MATERIALS AND PROPORTIONING	1.3. SUBMITTALS	1.3.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
			1.3.B. Informational Submittals: Submit the following:	Certifications: Submit concurrent with, but separate from, associated Shop Drawings and product data Submittals
				Test Reports
				Supplier's Instructions: Submit concurrent with, but separate from, associated product data Submittals
03 31 31	CONCRETE MIXING, PLACING, JOINTING, AND CURING	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
				Samples

Exhibit A – Submittal Register (Draft Submittal List)				
SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
				Monitoring Procedures
			1.5.B. Informational Submittals: Submit the following:	Delivery Tickets
				Supplier Instructions
				Field Quality Control Submittals
				Supplier Site Visit Reports
				Special Procedure Submittals
				Qualifications
03 35 00	CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Certifications
03 64 23	CRACK REPAIR AND INJECTION	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Product Data
			1.5.B. Informational Submittals: Submit the following:	Certifications
				Technical data for metering, mixing, and injection equipment.
				Manufacturer's Instructions
				Qualifications Statements
			1.5.C. Closeout Submittals: Submit the following:	Record documents that accurately depict actual locations of repaired cracks and type of crack injection materials used at each location. This may be shown and indicated on record drawings required in Section 01 78 39 - Project Record Documents.
04 01 20	MASONRY CLEANING	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
			1.3.B. Certifications:	Certification that Contractor is experienced in this type of masonry cleaning.
04 05 13	MASONRY MORTAR AND GROUT	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Test results
			1.4.B. Informational Submittals:	Qualifications of testing lab and technician. Test results and inspection reports per Specification Section 01 45 33.
04 05 23	MASONRY ACCESSORIES	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
04 22 00	CONCRETE MASONRY	1.4. SUBMITTALS	1.4.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
				Samples
			1.4.B. Informational Submittals: Submit the following:	Certifications
				Supplier Instructions
				Source Quality Control Submittals
				Field Quality Control Submittals
				Qualifications
05 12 00	STRUCTURAL STEEL	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data including
				Fabrication and/or layout drawings
				Certifications
				Test reports
05 30 00	METAL DECKING	1.4. SUBMITTALS	1.4.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
			1.4.B. Informational Submittals: Submit the following:	Certifications
				Supplier's Instructions
				Test and Evaluation Reports
				Source Quality Control Submittals
				Qualifications Statements
05 50 00	METAL FABRICATIONS	1.3. SUBMITTALS	1.3.A. Action Submittals: Submit the following:	Shop Drawings
				Product technical data (for fabrications not delegated design)
				Delegated Design Professional's "Instruments of Service" Submittals
			1.3.B. Informational Submittals:	Certifications
				Supplier's Instructions
				Qualifications Statements
				Delegated design Shop Drawings approved by delegated design professional
				Delegated design product data approved by delegated design professional
				Delegated design calculations in accordance with Section 01 35 73 - Delegated Design Procedures
05 52 23	STEEL RAILINGS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Fabrication and/or layout drawings.
				Product technical data
			1.4.B. Informational Submittals:	Certification of welders and welding procedures indicating compliance with AWS.
				Certification that railings have been designed and fabricated to meet the loading requirements specified.
05 52 43	WELDED ALUMINUM RAILINGS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Fabrication and/or layout drawings
				Product technical data
				Certification that railings have been designed and fabricated to meet the loading requirements specified.
				Calculations
			1.4.B. Informational Submittals:	Certification of welders and welding procedures indicating compliance with AWS requirements.
06 10 00	ROUGH CARPENTRY	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Fabrication drawings of all fabricated items.
				Product technical data including
				Certifications
				Documentation of treatment of treated material in accordance with standards referenced.
06 82 00	FIBERGLASS REINFORCED PLASTIC FABRICATIONS	1.5. SUBMITTALS	1.5.A. Shop Drawings:	Product technical data including
				Fabrication and/or layout drawings
				Certifications
				Manufacturer's full line of colors available for each component.
			1.5.B. Informational Submittals:	Complete design calculations of all supporting structure and fastening conditions.
07 17 00	BENTONITE COMPOSITE SHEET WATERPROOFING	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Certification of installer's qualifications.
				Manufacturer authorized representative written documentation of substrate acceptability.
07 21 00	BUILDING INSULATION	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
			1.3.B. Informational Submittals:	Certification from insulation manufacturer stating that insulation proposed is acceptable for intended use per the Drawings.
07 61 13	METAL ROOFING	1.5. SUBMITTALS	1.5.A. Shop Drawings:	Fabrication and/or layout drawings
				Product technical data including
				Test results
				Qualifications
				Roofing manufacturer's letter of approval for insulation proposed for use.
				Warranty: Sample language of manufacturer's warranty to be provided on this Project.
				Structural Engineer's sealed and signed calculations certifying that system structural components meet the requirements for lateral, upward and downward loads specified.
			1.5.B. Samples:	General: Tag, identify and provide statement regarding use for all fasteners, anchor clips, closures and sealants
				Roof panel
				Fasteners
				Anchor clips
				Closures, (both metal and non-metallic)
				Masonry reglet
				Factory and field applied sealants
				Color samples
			1.5.C. Contract Closeout Information:	Operation and Maintenance Data
			1.5.D. Informational Submittals:	Final warranty
07 62 00	FLASHING AND SHEET METAL	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Fabrication and/or layout drawings

Exhibit A – Submittal Register (Draft Submittal List)

SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
				Fabricator qualifications
				Installer qualifications
			1.4.B. Samples:	Finish and color samples for each product specified for Engineer preliminary color selection
				For final color selection, provide [two], 2 inches x 3 inches colored metal samples for each color selected during the preliminary color selection
			1.4.C. Informational Submittals:	Warranty: Manufacturer's sample warranty language
07 72 33	ROOF HATCHES	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Scaled plan of roof showing location of all units and anchoring details
				Product technical data including
			1.3.B. Contract Closeout Information:	Operation and Maintenance Data
			1.3.C. Informational Submittals:	Warranty
07 92 00	JOINT SEALANTS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied
				Certification of applicator qualification
			1.4.B. Test Results:	Provide adhesion test results for each sealant sample including adhesion results compared to adhesion requirements
				Manufacturer's authorized factory representative recommended remedial measures for all failing tests
			1.4.C. Samples:	Cured sample of each color for Engineer's color selection. Color chart not acceptable.
08 11 00	HOLLOW METAL DOORS AND FRAMES	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Schedule of doors and frames using same reference numbers as used on Drawings.
				SDI certification.
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
08 33 23	STEEL ROLLING OVERHEAD DOORS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Schedule of doors using same reference number for openings as indicated on Drawings.
				Certifications
				Test Reports
			1.4.B. Samples:	Actual metal color samples of manufacturer's full line of colors available.
			1.4.C. Contract Closeout Information:	Operation and Maintenance Data
08 51 13	ALUMINUM WINDOWS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data for framing system and major accessories
				Elevation drawings indicating window dimensions and details.
			1.4.B. Samples:	After initial color selection, provide 2 x 3 inches minimum sample of each color and finish selected.
			1.4.C. Informational Submittals:	Qualifications of testing laboratory.
				Test results.
				Warranty.
08 70 00	FINISH HARDWARE	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Qualifications
				Certificationstatement from AHC
				Product technical data
				Schedule of all hardware being used on each door.
				Technical data sheets on each hardware item proposed for use.
				Warranty information for all hardware devices having extended warranties.
			1.4.B. Informational Submittals:	Certifications
08 81 00	GLASS AND GLAZING	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Certification that insulating glass units meet requirements of IGCC and are certified by IGCC to ASTM E2190.
			1.4.B. Samples:	Two, 6x 6 inches sample of each type, color, and thickness specified.
			1.4.C. Informational Submittals:	Warranty.
08 90 00	LOUVERS AND VENTS	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Drawing showing location of each louver or vent, indicating size and arrangement of blank-off plates if required.
				Product technical data
09 22 16	NON-STRUCTURAL METAL FRAMING	1.3. SUBMITTALS	1.3.A. Product Data:	Manufacturer's specifications for each type of material and accessory.
				Where EQ coatings are used, submit copies of nationally recognized testing laboratory results showing conformance with ASTM A653 and AISI S220.
			1.3.B. Shop Drawings:	Sizes and spacing of typical framing members and opening framing.
				Show locations and sizes of atypical framing members, wall framing sections, and opening elevations.
				Methods of fastening framing members to each other and to supporting systems.
				Details of vertical deflection connections to structures.
				Locations and spacing of lateral bracing and structural bracing systems.
				Accessory products required for complete installation.
09 29 00	GYPSUM BOARD	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Drawings of unusual conditions.
				Product technical data
				Manufacturer's adhesive, joint treatment compound and tape recommendations.
09 96 00	HIGH PERFORMANCE INDUSTRIAL COATINGS	1.4. SUBMITTALS	1.4.A. Certifications:	Applicator experience qualifications.
				NACE inspector certification.
				NACE inspector experience qualifications.
				Certification that High Performance Coating Systems proposed for use have been reviewed and approved by a NACE Certified Coatings Inspector employed by the coating manufacturer.
			1.4.B. Shop Drawings:	Product technical data
				Manufacturer's statement regarding applicator instruction on product use.
			1.4.C. Samples:	Manufacturer's full line of colors for Engineer's preliminary color selection.
				After preliminary color selection by Engineer provide two, 3x5 inches samples of each final color selected.
			1.4.D. Informational Submittals:	Approval of application equipment.
				Applicator's daily records:
10 14 00	IDENTIFICATION DEVICES	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
				Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.
				Schedule of Hazard and Safety Signage indicating text and graphics.
10 14 23	SIGNAGE	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Schedule of all signs indicating text and graphics.
				Layout drawings of all signage showing size, letter style, text, border, finish, and installation detail.
			1.4.B. Samples:	Room and exit identification signs.
				Aluminum letters.
10 44 33	FIRE PROTECTION SPECIALTIES	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
22 15 00	GENERAL SERVICE COMPRESSED-AIR SYSTEMS	1.3. SUBMITTALS	1.3.B. Shop Drawings:	Indicate piping system schematic with electrical and connection requirements general assembly of components, mounting and installation details, and general layout of control and alarm panels.
			1.3.C. Product Data:	Piping: Submit data on pipe materials, fittings, and accessories.
				Valves: Submit manufacturers catalog information with valve data and ratings for each service.
				Hangers and Supports: Submit manufacturers catalog information including load capacity.
				System Components: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes. When applicable, include electrical characteristics and connection requirements.
				Compressors: Submit type, capacity, and performance characteristics. Include electrical characteristics and connection requirements.
			1.3.D. Product Data:	Submit manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
			1.3.E. Manufacturer's Installation Instructions:	Submit hoisting and setting requirements, starting procedures.
			1.3.F. Manufacturer's Certificate:	Certify products meet or exceed specified requirements.

Exhibit A – Submittal Register (Draft Submittal List)

SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
			1.3.G. Contract Closeout Information:	Operation and Maintenance Data:
23 05 48	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT	1.4. SUBMITTALS	1.4.B. Product Data:	Submit schedule of vibration isolator type with location and load on each.
				Submit manufacturer catalog information indicating materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
			1.4.C. Shop Drawings:	Indicate static and dynamic load of vibration isolators.
			1.4.D. Manufacturer's Certificate:	Certify that products meet or exceed specified requirements.
			1.4.E. Delegated Design Submittals:	Submit signed and sealed Shop Drawings with design calculations and assumptions indicating that maximum room sound levels are not exceeded.
			1.4.F. Test and Evaluation Reports:	Indicate that acoustic housings meet or exceed specified sound transmission loss values.
			1.4.G. Manufacturer Instructions:	Submit special procedures and setting dimensions.
				Indicate installation requirements maintaining integrity of sound isolation.
			1.4.H. Field Quality-Control Submittals:	Indicate results of Contractor-furnished tests and inspections.
			1.4.I. Manufacturer Reports:	Certify that sound isolation installation is complete and complies with instructions.
			1.4.J. Qualifications Statements:	Submit qualifications for manufacturer, installer, and licensed professional.
				Submit manufacturer's approval of installer.
			1.4.K. Contract Closeout Information:	Operation and Maintenance Data:
				Project Record Documents:
23 05 53	IDENTIFICATION FOR HVAC, DUCTWORK, PIPING AND HVAC EQUIPMENT	1.3. SUBMITTALS	1.3.A. Product Data:	Submit manufacturers catalog literature for each product required.
			1.3.B. Shop Drawings:	Submit Identification Register including list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
			1.3.C. Manufacturer's Installation Instructions:	Indicate installation instructions, special procedures, and installation.
			1.3.D. Contract Closeout Information:	Operation and Maintenance Data:
				Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.
23 05 93	HVAC SYSTEMS - BALANCING AND TESTING	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Certifications
				Report forms
			1.3.B. Informational Submittals:	Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.
23 09 00	INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Wiring diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
				Information on equipment proposed for use including corrosion protection.
				Instrument loop diagrams and word description of loop function for each individual unit controlled including auxiliary interlocks in full compliance with ISA S5.4.
			1.4.B. Quality Control Submittals:	Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.
			1.4.C. Contract Closeout Information:	Operation and Maintenance Data
23 31 00	HVAC - DUCTWORK	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Efficiency ratings per ASHRAE 52 for factory built and assembled filter units.
				Scaled ductwork drawings (1/4 inches equals 1 foot) showing duct and accessory layout and support.
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
			1.4.C. Miscellaneous Submittal:	Documentation of qualifications for fabricators and installers
23 34 00	HVAC - FANS	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
				Certifications
			1.3.B. Factory Performance test for any fan having a flow rate greater than 1,000 cfm and/or a total static pressure rating equal to or greater than 1.5 inches WC.	Pursuant to AMCA Publication 203 or 210 with no plus tolerances on Power and no minus tolerances on flow or pressure.
23 34 00	HVAC - FANS	1.3. SUBMITTALS	1.3.C. Contract Closeout Information:	Operation and Maintenance Data
23 80 00	HVAC - EQUIPMENT	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Fabrication and/or layout drawings.
				Product technical data
				Certifications:
			1.3.B. Contract Closeout Information:	Operation and Maintenance Data:
26 05 00	ELECTRICAL - BASIC REQUIREMENTS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	See Specification Section 016103 and individual specification sections for submittal requirements for products defined as equipment.
				General requirements
				Fabrication and/or layout drawings
			1.4.B. Operation and Maintenance Manuals:	See Specification Section 017823 for requirements for the content process of Operation and Maintenance Manuals.
26 05 09	MOTORS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Fabrication and/or layout drawings
				Certifications
				Test reports
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
				Installation instructions.
				Operation and maintenance instructions.
				Recommended spare parts list.
26 05 19	WIRE AND CABLE - 600 VOLT AND BELOW	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Miscellaneous
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data:
26 08 13	ACCEPTANCE TESTING	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Equipment Monitoring and Testing Plan.
			1.3.B. Informational Submittals:	Prior to energizing equipment: Coordinated phasing diagram & Photocopies of continuity tests.
				Within two weeks after successful completion of Demonstration Period (Commissioning Period): Single report containing information including:
26 20 00	ELECTRICAL DISTRIBUTION SYSTEM	1.4. SUBMITTALS	1.4.A. Owner approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Owner.	SD-02 Shop Drawings
				SD-03 Product Data
				SD-06 Test Reports
				SD-07 Certificates
				SD-09 Manufacturer's Field Reports
				SD-10 Operation and Maintenance Data
26 24 19	MOTOR CONTROL EQUIPMENT	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
				Fabrication and/or layout drawings
			1.3.B. Contract Closeout Information:	Operation and Maintenance Data
			1.3.C. Informational Submittals:	Equipment marking and documentation.
26 29 23	VARIABLE FREQUENCY DRIVES - LOW VOLTAGE	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Provide a schedule for each VFD
				Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
				Product technical data
				Fabrication and/or layout drawings
				Certifications
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
				Approved copy of VFD schedule per Submittals Article.
				Manufacturer's instruction manuals.
				Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
				Connection data to permit removal and installation of recommended smallest field-replaceable parts.
				Recommended spare parts list.

Exhibit A – Submittal Register (Draft Submittal List)				
SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
				Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.
26 32 15	ENGINE GENERATOR - NATURAL GAS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Fabrication and/or layout drawings
				Test reports
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
			1.4.C. Informational Submittals:	Unit installation, startup and operational statement. Field Quality Control test reports.
26 50 00	INTERIOR AND EXTERIOR LIGHTING	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Test Reports
				Certifications: Solid-state Luminaire Useful Life Certificate.
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
31 10 00	SITE CLEARING	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Shop Drawings
			1.5.B. Informational Submittals: Submit the following:	Permits and Approvals
				Certificates
				Qualifications Statements
31 22 19	FINISH GRADING	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Product Data
				Samples
			1.5.B. Informational Submittals: Submit the following:	Quality Assurance Test Results Submittals
				Qualifications Statements
31 23 05	EXCAVATION AND FILL	1.5. SUBMITTALS	1.5.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
			1.5.B. Informational Submittals: Submit the following:	Procedure Submittals
				Quality Assurance Test Results Submittals
				Field Quality Control Submittals
				Qualifications Statements
31 23 33	UTILITIES - TRENCHING AND BACKFILLING	1.4. SUBMITTALS	1.4.A. Action Submittals: Submit the following:	Shop Drawings
				Product Data
			1.4.B. Informational Submittals: Submit the following:	Procedure Submittals
				Quality Assurance Test Results Submittals
				Field Quality Control Submittals
				Qualifications Statements
32 13 13	CONCRETE PAVING	1.6. SUBMITTALS	1.6.A. Submittals Required Under Other Sections:	Concrete materials and supplemental materials
				Reinforcing steel required for concrete paving
				Shop Drawings and product data Submittals for joint materials and sealants for concrete paving
				Delivery tickets
				Field quality control Submittals.
			1.6.B. Action Submittals: Submit the following:	Shop Drawings Mix designs for concrete paving
				Product Data
				Samples
			1.6.C. Informational Submittals: Submit the following:	Special Procedure Submittals
				Field Quality Control Submittals
				Qualifications Statements
32 16 23	CONCRETE SIDEWALK AND STEPS	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
				Mix design(s) in accordance with Specification Section 03 31 30 and Specification Section 03 05 05.
				Qualifications of concrete installer.
				Drawings detailing all reinforcing.
				Concrete cylinder test results from field quality control.
			1.3.B. Samples:	Samples of fabricated jointing materials and devices.
32 31 13	CHAIN LINK FENCE AND GATES	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
				Mill certificates.
				Source quality control test results.
40 05 00	PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
			1.3.B. Contract Closeout Information:	Operation and Maintenance Data
			1.3.C. Informational Submittals:	Test reports
40 05 51	COMMON REQUIREMENTS FOR PROCESS AND UTILITY VALVES	1.3. SUBMITTALS	1.3.A. Action Submittals:	Shop Drawings
				Product technical data
			1.3.B. Informational Submittals:	Test reports if required in the individual valve specification.
			1.3.C. Closeout Submittals:	Operation and Maintenance Data
40 05 61	GATE VALVES	1.4. SUBMITTALS	1.4.A. Shop Drawings:	See Specification Section 40 05 51
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
40 05 63	BALL VALVES	1.4. SUBMITTALS	1.4.A. Shop Drawings:	See Specification Section 40 05 51
				Test results for AWWA valves.
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
40 05 64	BUTTERFLY VALVES	1.3. SUBMITTALS	1.3.A. Action Submittals: Submit the following:	See Specification Section 40 05 51
			1.3.B. Informational Submittals: Submit the following:	For valves 8 inches and larger specified to comply with AWWA C504, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504.
			1.3.C. Closeout Submittals: Submit the following:	Operation and Maintenance Data
40 05 66	CHECK VALVES	1.4. SUBMITTALS	1.4.A. Action Submittals: Submit the following:	In accordance with Section 40 05 51
			1.4.B. Informational Submittals: Submit the following:	In accordance with Section 40 05 51
				Manufacturer's Instructions
			1.4.C. Closeout Submittals: Submit the following:	Operation and Maintenance Data
40 42 00	PIPE, DUCT AND EQUIPMENT INSULATION	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data including
				Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
				Certifications: Products will meet the requirements of the Contract Documents.
40 61 13	PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS	1.5. SUBMITTALS	1.5.A. Shop Drawings:	Product technical data
				Comprehensive asset inventory of all networked components
				Network Diagrams
				Comprehensive set of wiring diagrams as specified in Section 40 67 00
				Panel fabrication drawings as specified in Section 40 67 00
				PLC equipment drawings
				OIT graphics
				Nameplate layout drawings
				Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3
				All panel and wiring drawings shall be provided in both hardcopy and softcopy.
				Provide a parameter setting summary sheet for each field configurable device.
				Certifications
				Testing reports: Source quality control reports.
			1.5.B. Qualifications Submittal:	Documentation verifying contractor/subcontractor adherence to specified certifications and qualifications
			1.5.C. Contract Closeout Information:	Operation and Maintenance Data
				All Shop Drawings shall be modified with as-built information/corrections.
				Instrumentation and Control Equipment Operation and Maintenance Manual Content
				Warranties: Provide copies of warranties and list of factory authorized service agents.

Exhibit A – Submittal Register (Draft Submittal List)				
SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
40 61 93	PROCESS CONTROL SYSTEM INPUT-OUTPUT LIST	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Any proposed deviations from the I/O List format, content and attributes stipulated in this Section shall be submitted for approval. I/O List development shall not proceed until the deviation has been approved.
				Pre-fabrication I/O Lists for approval.
			1.3.B. Operation and Maintenance Manuals:	See Specification Section 017823 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
			1.3.C. Informational Submittals:	I/O Lists
			1.3.A. Contract Closeout Information:	Operation and Maintenance Data
40 63 43	PROGRAMMABLE LOGIC CONTROLLERS	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Product technical data
				Certifications
				Software Licenses
				Manufacturer support proposal [agreement].
			1.3.B. Operation and Maintenance Data:	See Specification Section 017823 for requirements for the content of Operation and Maintenance Manuals.
				Program Documentation.
				Maintenance procedures.
40 66 40	TELEMETRY SYSTEMS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Catalog cut sheets
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
			1.4.C. Informational Submittals:	Clear listing of all passwords required to edit, modify, or view programming and configuration.
				Radio Study/Survey Staff/Subcontractor Qualification Verification (upon request)
				Radio site survey results
				List of all recommended spares for maintenance purposes with each item separately priced.
				Results of factory testing procedures.
			1.4.D. Field Quality Control.	Items listed under Part 3, 3.2 of this specification section.
40 67 00	CONTROL SYSTEM EQUIPMENT PANELS AND RACKS	1.4. SUBMITTALS	1.4.A. See Section 40 61 13.	
			1.4.B. Shop Drawings:	Table of contents sheet(s).
				Legend and abbreviation sheets.
				Panel exterior layout drawings.
				Panel interior layout drawings.
				Wiring diagrams.
				Communication network drawing(s).
				Bill of Material for each panel.
				Panel door weight calculation.
				Electrical load calculations for each panel.
				Climate control calculations for each panel.
			1.4.C. Product Data:	Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.
			1.4.D. Contract Closeout Information:	Operation and Maintenance Data
			1.4.E. Informational Submittals:	Unwitnessed Factory Testing confirmation of completion. Record Drawings
40 67 00	CONTROL SYSTEM EQUIPMENT PANELS AND RACKS	1.5.SUBMITTAL REQUIREMENTS	1.5.A. Shop Drawings:	
				Plant or facility name where panel(s) are to be installed.
				Drawing title.
				Drawing number.
				Revision list with revision number and date
				Drawing date.
				Drawing scale.
				Manufacturer name, address, and telephone number.
				Plant or facility name.
				Project name.
				Submittal description.
				Revision number.
				Issue date.
				Drawing number.
				Drawing title.
				Sheet number.
				Description of symbols and abbreviations used.
				Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
				Confirmation that the panel(s) are to be affixed with a UL508A or UL698A label prior to shipment from the factory.
				Instrument tag number.
				Quantity.
				Functional name or description.
				Manufacturer.
				Complete model number.
				Size or rating.
				Panel materials of construction, dimensions, and total assembled weight.
				Panel access openings.
				Conduit access locations.
				Front view, side views and top view of enclosure.
				Front panel device layout.
				Nameplate schedule:
				Alarm annunciator window engraving schedule.
				Layouts of graphic panels or mosaic displays.
				Include a statement on the drawings that indicates that the panel has been built as per UL508A or UL698A standards.
				Sub-panel or mounting pan dimensions.
				Interior device layouts indicating dimensioned location of devices.
				PLC/RTU general arrangement layouts.
				Wire-way locations, purpose, and dimensions. Include center line dimensions for all DIN rail and wire-way.
				Terminal strip designations.
				Location of external wiring and/or piping connections.
				Location of lighting fixtures, switches and receptacles.
				Include interior legends as per UL requirements.
				Panel power distribution diagrams.
				Control and instrumentation wiring diagrams.
				PLC/RTU I/O information:
				Internal network connections diagram
				Wiring diagrams shall identify each wire as it is to be labeled.
				Wiring diagrams shall include line/ rung references.
				Relay coils and their associated contacts shall be cross referenced to each other and clearly identified on the drawings.
				Wires leaving the sheet shall clearly indicate the continuation sheet and line/ rung references.
				Network equipment
				Interconnections between all network equipment within the panel.
				Connection to the plant network.

Exhibit A – Submittal Register (Draft Submittal List)				
SECTION NUMBER	SECTION NAME	ARTICLE	TYPE	DETAILS
			1.5.B. Verify that panel door mounted equipment will not exceed the maximum allowed weight as per manufacturer's specification.	Submit panel door weight calculation. Include weight of computer if using a laptop shelf. Panel current drawing based on connected load.
			1.5.C. Electrical load calculations for each panel:	
				SSCR Calculations.
				UPS Run time calculations.
				DC power supply load calculations.
				Climate control calculations for each panel.
				Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.
				Submit control panel heat release calculations (Watts or BTU/HR). Verify results with cooling/heating software. Submit heating and/or cooling equipment as required. Refer to Section 2.1.
				Provide temperature monitoring switch when an air conditioner is required by heat release calculations. High Temperature switch shall be wired to a PLC discrete input for temperature monitoring.
				Provide temperature monitoring switch when heater is required by heat release calculations. Low temperature switch shall be wired to a PLC discrete input for temperature monitoring.
				Air conditioners shall have built-in temperature display.
40 71 00	FLOW INSTRUMENTATION	1.2. SUBMITTALS	1.2.A. Shop Drawings:	See Specification Section 40 61 13.
			1.2.B. Operation and Maintenance Manuals:	See Specification Section 017823 for requirements for the content of Operation and Maintenance Manuals.
			1.3.A. Shop Drawings:	See Specification Section 40 61 13.
			1.3.B. Operation and Maintenance Manuals:	See Specification Section 017823 for requirements for the content of Operation and Maintenance Manuals.
40 73 00	PRESSURE INSTRUMENTATION	1.3. SUBMITTALS	1.3.A. Shop Drawings:	See Specification Section 40 61 13.
			1.3.B. Operation and Maintenance Manuals:	See Specification Section 017823 for requirements for the content of Operation and Maintenance Manuals.
40 74 00	TEMPERATURE INSTRUMENTATION	1.3. SUBMITTALS	1.3.A. Shop Drawings:	See Specification Section 40 61 13 - Process Control Systems General Requirements.
			1.3.B. Operation and Maintenance Manuals:	See Specification Section 017823 for requirements for the content of Operation and Maintenance Manuals.
40 78 00	PANEL MOUNTED INSTRUMENTS	1.3. SUBMITTALS	1.3.A. Action Submittals: Submit the following:	Shop Drawings
			1.3.B. Closeout Submittals: Submit the following:	Operation and Maintenance Data
41 22 13	OVERHEAD BRIDGE CRANE	1.3. SUBMITTALS	1.3.A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.	Submittals for approval shall be provided for the following categories or subcomponents of the bridge crane. Detailed requirements follow below. Hoist Trolley Trolley rail or beam details Hook Chain Electric motor data Coatings Electrification system, and pendants Schematics and wiring diagrams Factory and Field Test Results
				The Contractor shall provide complete catalog information, descriptive literature, materials of construction; and specifications on the bridge drive system, end trucks, runway stops, wheels, shafting, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, pendant control, and accessories.
				All bills of materials and materials of construction shall include ASTM designations.
				Equipment Drawings
				Coating information in accordance with Section 09 96 00
				Calculations
				Electrical Data
				Welding Procedures and Qualifications
				Weld repair procedures
				Stainless steel pickling and passivation procedure.
				Seismic Qualification
				Certified Material Test Reports (MTRs) of major crane components
				Project-specific Quality Assurance Plan (QAP)
				Process crane manufacturer's qualifications
				Proposed Installation Sequence and Outage Plan
				Installation, Operations and Maintenance
				Spare Parts and Special Tools
				Factory and Field Testing
43 21 00	PUMPING EQUIPMENT - BASIC REQUIREMENTS	1.4. SUBMITTALS	1.4.A. Shop Drawings:	Product technical data
				Certifications
				Test reports
			1.4.B. Contract Closeout Information:	Operation and Maintenance Data
			1.4.C. Informational Submittals:	Certifications
43 24 05	VERTICALLY SUSPENDED CENTRIFUGAL PUMPS	1.3. SUBMITTALS	1.3.A. Action Submittals: Submit the following:	Shop Drawings
			1.3.B. Informational Submittals	Factory Test Reports
				Field Test Reports.
			1.3.C. Contract Closeout Information:	Operation and Maintenance Data:
46 21 12	INLINE CANAL TRAVELING SCREENS	1.3. SUBMITTALS	1.3.A. Shop Drawings:	Scaled plan and sections showing dimensions, weights, structural supports, embedments, clearances, and screen discharge interface.
				Minimum screenings lifting capacity.
				Minimum gear reducer output torque.
				Installation list.
				Field lift test report.
			1.3.B. Contract Closeout Information:	Operation and Maintenance Data

Exhibit 01 33 00-B

Transmittal for Submittal

_____-_____

Project Name:		Date Received:	
Project Owner:		Checked By:	
Contractor:	HDR Engineering, Inc.	Log Page:	
Address:	Address:	HDR No.:	
		Spec Section:	
		Drawing/Detail No.:	
Attn (Contractor):	Attn (HDR):	Review Cycle	
Date Transmitted by Contractor:	Date of Engineer's Response Transmittal:		

Item No.	Submittal No.	Description (indicate number of copies where paper copies of physical Samples are returned)	Manufacturer	Supplier Dwg or Data No.	Engineer's Disposition (Action Code) *
1					
2					
3					
4					

Contractor's Remarks *(insert text)*:

Engineer's Remarks *(insert text)*: :

* **Legend for Action Code** indicated above, assigned by Engineer:

Action Submittal:
- A – Approved
- B – Approved as Noted
- C – Revise and Resubmit
- D – Not Approved
- E – Submittal Not Reviewed

Informational, Closeout, or Maintenance Materials Submittal:
- F – Accepted (this code normally recorded in Engineer's Submittals log).
- G – Not Acceptable

Engineer's Disclaimer (for Submittals that do not involve delegated design):

a. Submittal action code is subject to: Engineer's comments on the Submittal, comment sheets (if any), and this transmittal letter; disclaimer language on Engineer's Submittal review stamp or equivalent; and Specifications Section 01 33 00 – Submittal Procedures.

b. Engineer's review is only for general compatibility with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, and for general compliance with the information given in the Contract Documents.

c. Contractor shall be solely responsible for complying with the Contract Documents, as well as with Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations. Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the work of all trades.

Reviewed for HDR by:	**Date of Engineer's Review:**

Distribution: Contractor ☐ File ☐ Field ☐ Owner ☐ Other ☐

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SECTION 01 35 73
DELEGATED DESIGN PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General provisions for delegated design services.
2. Coordination of delegated designs with other Work.
3. Qualifications requirements for delegated design professionals.
4. Limitations on Engineer's review of delegated design Submittals.
5. Responsibilities of delegated design professionals.

B. Scope:

1. Where delegated design is specifically Contractor's responsibility in accordance with the Contract Documents, Contractor shall provide labor, services, other effort, and pay all costs necessary and required to perform delegated design services for Work that will be part of the completed Project as a functioning whole.
2. Perform delegated design Work in accordance with the Contract Documents, delegated design Action Submittals approved by Engineer, and Shop Drawings, product data Submittals, and Samples approved by the associated delegated design professional.
3. Contractor's correction period, general warranty and guarantee, and obligations for safety and protection apply to delegated design Work to the same extent such provisions apply to all other Work under the Contract.
4. Specifications requiring delegated design services include, but are not necessarily limited to, the following:
   a. Section 05 50 00 – Metal Fabrications.
   b. Section 05 52 23 – Steel Railings.
   c. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements
   d. Section 40 05 07 – Pipe Support Systems
   e. Section 46 21 12 – Inline Canal Traveling Screen
   f. Section 06 82 00 – Fiberglass Reinforced Plastic Fabrications
5. Not Delegated Design: The following are not delegated design and are not covered by this Section:
   a. Contractor's use of design professionals for: (1) temporary construction or temporary facilities not part of the completed Project as a functioning whole, or (2) Contractor's means, methods, procedures, techniques, and sequences of construction and safety and protection measures incident thereto.
   b. Certain final designs that, in accordance with commonly accepted practice, are typically prepared by unlicensed, unregistered individuals, including for manufactured or fabricated systems, components or assemblies, not acting under the supervisory control of the design professional in responsible charge, but who commonly possess appropriate certification from a relevant industry organization, together with appropriate training and experience.

C. Related Requirements:

1. Sections of Divisions 02-49 where delegated design Work is required.

1.2 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters but, when used in this Section and Specifications of Division 02-49 where delegated design Work is required, have the meaning indicated below:
    a. “Delegated design” means preparing the final design of part of the completed, permanent Work by one or more delegated design professionals, in accordance with the Contract Documents. The terms “delegated design”, “delegated design services”, “delegation of design responsibility”, and similar or derivative terms have the same meaning.
    b. “Delegated design professional” means the licensed and registered engineer, architect, geologist, or other design professional retained by or employed by Contractor, Subcontractor, or Supplier to perform delegated design services for delegated design Work and possessing appropriate experience and qualifications for such delegated design services.
    c. “Delegated design Work” means delegated design services, associated construction, and related Work.
    d. “Instruments of service”, relative to delegated designs, means delegated design professional’s: (1) certifications (including delegated design professional’s certification of compliance, as required in this Section, and other certifications required of delegated design professional), (2) reports (where required), (3) design drawings, (4) design specifications, (5) other documents specifically indicated as delegated design professional’s “instruments of service” in the Contract Documents, and (6) documents modifying a delegated design (after Engineer’s approval of the original delegated design Submittals). “Instruments of service” are to be sealed, signed, and dated by delegated design professional and expressly required as Submittals. Shop Drawings sealed and signed by delegated design professional are delegated design professional’s “instruments of service”.

1.3 GENERAL PROVISIONS CONCERNING DELEGATED DESIGN SERVICES

A. Delegated Designs - General:

1. This Section augments the requirements of the General Conditions, as may be amended by the Supplementary Conditions, and other provisions of the Contract Documents regarding Contractor’s responsibilities for delegated design Work.
2. Delegated design professionals or their employer shall furnish professional liability insurance. Provisions on professional liability insurance are set forth in the Supplementary Conditions. Submit through Contractor appropriate documentation of professional liability insurance.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordination - General:
    a. Contractor shall coordinate the services of delegated design professionals with all other elements of the Work.
    b. Contractor has full responsibility for scheduling delegated designs and all related Work.
    c. Allow sufficient time in Progress Schedule for performance of delegated design services, including requests for interpretation or clarification between delegated design professional and Contractor and between Contractor and Engineer.
2. Coordination of Delegated Design Work’s Connections to Other Work:
    a. Where delegated design Work connects to other Work designed by Engineer, existing construction, or both, the delegated design Work shall be consistent with the other Work and existing construction to which delegated design Work connects, and adjacent construction.
    b. Submit details, loading, anchorage, and other coordinating information necessary for the delegated design Work to properly interface with Work designed by Engineer.

c. Changes in the Work, whether designed by Engineer, designed by delegated design professional, or existing construction, necessary as a result of the delegated design are ineligible for increase in Contract Price or Contract Times, unless: (1) otherwise agreed by both Engineer and Owner, or (2) expressly indicated otherwise elsewhere in the Contract Documents for the associated delegated design Work.

d. Changes requiring extra compensation, time, or both arising from delegated design aspects needed for convenience of Contractor, Subcontractor, or Supplier, are not grounds for increase in Contract Price or Contract Times.

3. Coordination of Submittals, Fabrication, Production, and Shipment:

a. Do not release for raw materials procurement, fabrication, production, and shipment to the Site materials, equipment, or systems designed by delegated design professional until the associated delegated design professional has reviewed and approved all associated Shop Drawings, product data, Samples, and (relative to shipment) source quality control Submittals, and such Submittals have been delivered to and accepted by Engineer.

1) For delegated design systems that required reactions to be submitted to the Engineer. These submittals shall be submitted and approved first before approval is given for the delegated design submittal.

b. Allow sufficient time in the Progress Schedule for required Submittals and required actions by delegated design professionals and Engineer.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Delegated Design Professionals:

a. Each delegated design professional shall possess not less than the minimum qualifications set forth in this provision. Where the Specifications for the associated delegated design Work establish more-stringent qualifications requirements, comply with the more-stringent requirements.

b. Each delegated design professional shall comply with all of the following:

1) Legally qualified, as both an individual and as a business entity, to practice the associated design discipline(s) in the jurisdiction where the Site is located, including possessing current, valid license and registration for the design discipline(s) for which the delegated design professional will render its services on the Project.

2) Possess not less than five years of experience in the subject design discipline(s).

3) Served as design professional in responsible charge on not less than five other designs similar in scope and complexity to the Work for which delegated design professional is retained on the Project; construction of such prior projects shall be complete by the start of the Project's construction.

c. Summary of Qualifications: Submit to Engineer summary of delegated design professional's experience and qualifications, including:

1) Evidence of coverage under appropriate professional liability insurance in accordance with the Contract Documents.

2) Evidence of delegated design professional's ability to legally conduct business as a design professional in the same jurisdiction as the Site, as a business entity.

3) Copy of delegated design professional's current, valid personal design professional license and registration for the same jurisdiction as the Site. Such documents shall indicate the individual's name, license or registration number, and dates for which the license or registration is valid.

4) Other information reasonably requested by Engineer.

1.6 GENERAL PROVISIONS FOR DELEGATED DESIGN SUBMITTALS

A. Under the Division 02-49 Specifications section(s) where delegated design Work is required, furnish to Engineer Submittals such as:

1. Action Submittals:
    a. Delegated design professional's instruments of service Submittals.
2. Informational Submittals:
    a. When delivered to Engineer, the following must bear delegated design professional's Submittal approval stamp:
        1) Shop Drawings, product data Submittals, Samples, testing plans.
        2) Results of source quality control and field quality control activities.
    b. Delegated design professional's calculations.
    c. Reports of delegated design professional's visits to the Site, bearing delegated design professional's dated signature.
    d. Other Informational Submittals required for the subject delegated design Work.

B. Limitations of Engineer's Review of Delegated Design Submittals:
1. Delegated Design Professional's Instruments of Service Submittals:
    a. Engineer's review of delegated design instruments of service Submittals is for the limited purposes indicated in the General Conditions, as maybe modified by the Supplementary Conditions.
    b. The following disclaimer applies to Engineer's responses to delegated design professional's instruments of service Submittals:
        1) Engineer's review and approval of delegated design instruments of service is only for the limited purpose of verifying that performance and design criteria given in the Contract were used in the delegated design, and checking for compliance with the Engineer's design concept expressed in the Contract Documents.
        2) Contractor is solely responsible for complying with: the Contract Documents, Subcontractor and Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations.
        3) Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the Work of all trades.
        4) Engineer is not responsible for the effects of resubmittals or tracking progress of resubmittals.
2. Delegated Design Informational Submittals:
    a. Other provisions of the Contract Documents notwithstanding, Engineer's review of delegated design Informational Submittals is limited to only:
        1) Verifying the Submittal was furnished as required; and
        2) Submittal generally appears complete (except for calculations); and
        3) Submittal bears delegated design professional's approval stamp; or, for calculations prepared by or for delegated design professional, that such calculations bear delegated design professional's seal, signature, and date; or, for delegated design professional's reports of visits to the Site, that such report is legible, and bears delegated design professional's signature with date.
    b. Engineer receives such Submittals, including delegated design professional's calculations, on behalf of Owner, for Owner's records.
    c. Engineer, Owner, and others involved in the Project have the right to rely on delegated design professional's approval stamp as meaning that the delegated design professional has performed an appropriate review of the Submittal and determined it to be complete, in accordance with delegated design professional's instruments of service approved by Engineer, in accordance with delegated design professional's design intent, and in accordance with the Contract Documents.
3. Engineer's Other Comments on Delegated Design Submittals:

a. Despite the limitations of Engineer's review of Submittals for delegated design Work, should Engineer become aware of, or reasonably suspect existence of, potential of associated delegated design Work to adversely affect health, safety, or welfare of persons, or pose reasonable potential for damage to the Work, work of other contractors, or adjacent property, Engineer will advise Contractor in writing of general nature of Engineer's concern.

b. Such advisory by Engineer, if issued, is rendered in good faith and does not in any way constitute:

1) Engineer's review of all aspects of the delegated design.

2) Any sharing by Engineer of any of delegated design professional's responsibilities or professional liability.

3) Any responsibility imposed, in any way, on Engineer for any aspect of the delegated design professional's services or design, beyond the limited purposes of Engineer's review as set forth in the Contract Documents.

c. Contractor and its Subcontractors and Suppliers, including delegated design professionals, shall immediately investigate Engineer's concern indicated in such advisory and remedy as necessary and required.

d. Neither Engineer nor Owner, nor their respective consultants and subcontractors, is obligated to review any Submittal for delegated design Work beyond the limited review required by the Contract Documents. No such advisory, if issued, entitles Contractor, Subcontractor, or Supplier, including delegated design professionals, to rely on such advisory or to assume that any further such reviews or written or oral advisories are forthcoming.

1.7 RESPONSIBILITIES OF DELEGATED DESIGN PROFESSIONALS

A. Standard of Care:

1. Unless a higher standard of care is established by the Division 02-49 Specifications section where the associated delegated design Work is required, the delegated design services shall comply with the following standard of care:

a. Except as provided in the paragraph immediately above this, the standard of care for all delegated design professional services and related services performed or furnished by delegated design professionals for the Project will be the care and skill ordinarily used by members of the subject profession practicing under similar circumstances at the same time and in the same locality.

B. Responsibilities of delegated design professionals employed on the Work include, but are not necessarily limited to, the following, unless specifically indicated otherwise in the associated elements of the Contract Documents where the delegated design is required:

1. Ethical Conduct and Professionalism: Comply with Laws and Regulations and applicable standards and guidelines relevant design professional organizations for ethical conduct and professional practice.

2. Comply with Laws and Regulations and relevant design standards applicable to the subject delegated design Work.

3. Performance and Design Criteria Indicated in the Contract Documents and Other Information:

a. Review performance and design criteria, indicated in the Contract Documents, that the delegated design Work must satisfy.

b. Prepare written requests for interpretations or clarifications of performance or design criteria.

c. Review existing information about the Site that constitutes Technical Data (if any, applicable to the subject delegated design Work), as indicated in the Supplementary Conditions.

4. Site Information and Investigations: With Contractor, obtaining all other necessary dimensions, field information, and other information necessary for preparing delegated design Submittals.
5. Design and Other Professional Services: Personally perform and prepare, or actively exercise direct, personal, supervisory control over others performing or preparing:
    a. Necessary design professional evaluations of conditions, materials, and equipment.
    b. Prepare the instruments of service Submittals and calculations Submittal for the subject delegated design Work, where required by the associated Division 02-49 Specifications and other, associated Contract Documents.
    c. Assist Contractor with applying for and obtaining permits and approvals (not previously obtained by Owner or those for whom Owner is responsible) necessary for the delegated design Work.
    d. Review and approve or take other appropriate action on Shop Drawings (unless such Shop Drawings are sealed and signed by delegated design professional), product data, Samples, and testing plans, and other Submittals associated with the delegated design Work.
    e. Prepare modifications of the delegated design instruments of service as necessary.
6. Sealing and Signing:
    a. Seal, sign, and indicate date of sealing and signing, on all of the following when such Submittals are required by the Division 02-49 Specifications where the delegated design Work is required:
        1) Instruments of service Submittals, including certification of compliance required.
        2) Calculations.
        3) Modifications to the delegated design.
        4) Other documents required to be sealed and signed by Laws or Regulations or the Contract Documents.
    b. Sealing and signing documents in accordance with Laws and Regulations and the Contract Documents, prior to submittal (through Contractor) to Engineer, and for submittal to authorities having jurisdiction to obtain necessary permits and approvals.
    c. Sealing and signing shall be in accordance with Laws and Regulations.
7. Certification of Compliance by Delegated Design Professional:
    a. Schedule:
        1) Submit certification of compliance after Engineer's acceptance of delegated design professional's qualifications statement.
        2) Obtain Engineer's approval of certificate of compliance Submittal prior to furnishing other Submittals for delegated design Work under the same Specifications section, unless otherwise allowed by Engineer.
    b. Through Contractor, submit to Engineer, delegated design professional's written certification indicating:
        1) General Information: (1) Project name and designation, (2) Contractor name and Contract designation, (3) Subcontractor or Supplier name (when applicable), (4) full name of delegated design professional's business entity under which the delegated design services were performed, (5) full name and license number of the individual sealing and signing the subject delegated design Work, (6) specific elements of delegated design Work to which the certification applies, and (7) delegated design professional's seal, signature, and date of signature.
    c. Explicit certification that the subject delegated design complies with:
        1) All applicable performance and design criteria indicated in the Contract Documents. Expressly indicate on certification of compliance the specific performance and design criteria used in the delegated design, and reaction forces of the delegated design imparted to other Work and existing construction. Reaction forces imparted

from the delegated design elements to the Engineer's designed system shall include the following:

a) Reaction forces imparted from the delegated design elements to the Engineer's designed system shall be presented as follows:
   (1) Unfactored loads per category (dead, live, wind, seismic, etc.).
   (2) Load combinations presented in Load Factor Resistance Design (LRFD) format from each element transmitting load.
b) All Laws and Regulations.
c) Applicable design standards commonly applicable to such types of construction. Expressly indicate such design standards on the certification of compliance.
d) The applicable standard of care. Expressly indicate the applicable standard of care.

8. Approvals of Other Delegated Design Submittals:
   a. Review and taking appropriate action on Submittals for delegated designs:
   b. Such reviews and approvals or other appropriate action shall be to ascertain compliance with:
      1) Delegated design professional's design intent.
      2) Delegated design professional's instruments of service and calculations.
      3) Associated requirements of the Contract Documents.
   c. Delegated design professional's review stamp or facsimile thereof, review action or disposition concerning the associated Submittal for the delegated design, date of review, and name of person performing the review shall be clearly legible on the associated Submittals (except for delegated design professional's own instruments of service Submittals, calculations, and reports of delegated design professional's visits to the Site). Prominently display delegated design professional's Submittal review stamp or facsimile thereof on: (1) each sheet of Shop Drawings, (2) each major section of product data Submittals, (3) each Sample, (4) each testing plan, and (5) each other Submittal associated with the delegated design for which such review stamp is required.
   d. Do not apply delegated design professional's Submittal review stamp and comments, if any, over other text, tables, or graphics.
   e. Where review stamp or facsimile thereof is required, submit to Engineer only those Submittals for delegated design Work that bear delegated design professional's explicit approval of the Submittal.
9. Respond promptly to requests for interpretation or clarification on delegated design professional's instruments of service and other Submittals for the delegated design Work.
10. Progress and Quality of Construction of Delegated Design Work:
   a. Where appropriate for the subject delegated design Work, periodically visit the Site at appropriate intervals to observe the progress and quality of the subject delegated design Work.
   b. Where delegated design professional does not visit the Site during construction, keep informed of the progress and quality of the subject delegated design Work via discussions with Contractor, Subcontractor, and Suppliers, via photographic documentation, and other means acceptable to delegated design professional.
   c. Advise Contractor in writing when the subject delegated design Work is not in accordance with the delegated design professional's instruments of service (approved by Engineer) and related Submittals approved by delegated design professional.
   d. Furnish to entity that retained delegated design professional copy of delegated design professional's written report of each visit to the Site.
11. Modifications to Design:

a. Design appropriate modifications to the delegated design Work, including preparing new or revised certifications, reports, design drawings, sketches, design specifications, and calculations, as appropriate.
b. Such instruments of service and calculations shall be submitted to Engineer through Contractor to same extent original instruments of service Submittals and calculations, if any, where required by the Contract Documents for the subject delegated design Work.

12. Other services, as mutually agreed upon by delegated design professional and its client, or as required elsewhere in the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 42 00
REFERENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Defined terms and terminology.
2. Construction Codes: Indication of applicable building code and other construction codes.
3. Referenced Standard Specifications and Construction Guidelines: Indication of Owner's or third-party specifications and construction standards applicable to one or more parts of the Work.
4. Abbreviations in general use in the Contract Documents.
5. Reference Standards: General requirements regarding reference standards, including a listing of reference standard-issuing organizations (and their acronyms) used in the Contract Documents.

1.2 REFERENCES

A. Contract Language Addressed to Contractor:

1. Unless expressly indicated otherwise, language of the Contract Documents addresses Contractor, and the Contract Documents show and indicate Contractor's obligations.
2. Unless indicated otherwise, expressions such as, "provide", "furnish", "install", "perform", "retain services of", "remove", "demolish", "replace", and the like refer to Contractor's obligations under the Contract.

B. Defined Terms:

1. Defined terms, indicated with initial capital letters or with all-capital letters, used in the Contract Documents, are indicated in the General Conditions, as may be modified by the Supplementary Conditions. Additional defined terms, if any, in general use in the Contract Documents are indicated below. Where used, such defined terms apply to the singular and plural thereof.
   a. None.
2. Additional defined terms, applicable to the Work of a given Specifications Section, may be indicated in the associated Specifications Section.

C. Terminology:

1. Terminology, indicated without initial capital letters, used in the Contract Documents, are indicated in the General Conditions, as may be modified by the Supplementary Conditions. Additional terminology in general use in the Contract Documents are indicated below. Where used, such terminology applies to the singular and plural thereof.
   a. "Shown" means information or requirements presented on the Drawings, in schedules, or in other types of graphic instruments.
   b. "Indicated" means, as applicable: (1) graphic representations, notes, or schedules on the Drawings, or (2) other paragraphs, provisions, tables, or schedules in the Specifications and elsewhere in the Contract Documents.
   c. "Specified", "noted", "scheduled", and similar terms, have the same meaning as "shown" and "indicated", as applicable, and are used to help the user locate the reference without limitation on the location.
   d. "Installer", "applicator", or "erector" is Contractor's employees or Subcontractor, engaged to perform a specific construction activity, including installation, erection, application, or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.

e. “Experienced”, when used in conjunction with terms such as “installer”, “Subcontractor”, “Supplier”, “manufacturer”, and similar terms means (unless expressly indicated otherwise for the subject Work elsewhere in the Contract Documents) such person or entity, as applicable, has successfully completed not less than five previous projects similar in size, scope, and complexity to such person’s or entity’s work on this Project; being familiar with the special requirements indicated and required; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with written requirements of the Supplier of the material or equipment being installed.

f. “Assigned specialists” and similar terms: Certain Specifications require specific construction activities be performed by specialists with recognized, extensive experience in such operations. Engage said specialists for such activities, and their engagement is a requirement over which Contractor has no option. These requirements do not conflict with enforcement of building codes and other Laws and Regulations. Such requirements are not intended to interfere with local trade union jurisdictional settlements and similar conventions. Such assignments shall not relieve Contractor of responsibility for complying with the requirements of the Contract Documents.

g. Trades: Use of terms such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter”, unless otherwise indicated in the Contract Documents or required by Laws or Regulations, or required by an applicable project labor agreement. Such terminology also does not imply that indicated requirements apply exclusively to trade personnel of the corresponding generic name.

2. Additional terminology, applicable to the Work of a given Specifications Section, may be indicated in the associated Specifications Section.

1.3 REFERENCED STANDARD SPECIFICATIONS AND CONSTRUCTION GUIDELINES

A. Except as otherwise shown or indicated in the Contract Documents, the Work shall comply with the Contract Documents and the following referenced specifications and construction guidelines:

1. Idaho Transportation Department (ITD) Standard Specifications for Highway Construction (2023) and Standard Drawings (2024), which can be obtained at ITD website at https://apps.itd.idaho.gov/Apps/manuals/SpecBook/SpecBook23.pdf and https://apps.itd.idaho.gov/apps/standarddrawings/standarddrawings.htm.
2. Idaho Standards for Public Works Construction (ISPWC) Standard Drawings 2020, which can be obtained for a fee at the following website: https://lhtac.org/resources/ispwc/
3. NFPA 5000, Building Construction and Safety Code: 2018 Edition

B. Engineer is not the author of, is not responsible for, and did not seal and sign the referenced specifications and construction guidelines indicated above. Such referenced specifications and construction guidelines are not part of the Contract Documents. Where compliance with referenced specifications or construction guidelines is required by the Contract but requirements are unclear or conflict with requirements of the Contract Documents, submit to Engineer request for interpretation or clarification.

C. Maintain at the Site complete copy (in either paper or electronic form) of referenced specifications and construction guidelines indicated above. Make such copy available for Engineer’s, Resident Project Representative’s (RPR), or Owner’s Site Representative’s (OSR) use in Contractor’s field office at the Site.

1.4 ABBREVIATIONS.

A. Abbreviations - General:

1. Abbreviations commonly used in the Contract Documents are indicated in this Article or on the Drawings, except as further indicated in the following paragraphs,

2. Additional abbreviations, specific to the Work of a given Specifications section, may be indicated in the associated Specifications.
3. Typical equipment abbreviations are indicated in Section 01 61 03 - Equipment - Basic Requirements.
4. Piping system abbreviations are indicated in Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.5 REFERENCE STANDARDS AND ORGANIZATIONAL ACRONYMS

A. Reference Standards - General:

1. Each entity engaged in the Work, including Contractor, Subcontractors, and Suppliers, shall be familiar with reference standards applicable to its portion(s) of the Work. Comply with such reference standards when required by the Contract Documents or appropriate fabrication and construction practice, unless the Contract Documents requirements exceed those of the associated reference standard.
2. Refer to the General Conditions, as may be modified by the Supplementary Conditions, relative to reference standards and resolving discrepancies between reference standards and the Contract Documents.
3. Provisions of reference standards are in effect in accordance with the Specifications and other provisions of the Contract Documents where reference standards are cited.
4. Copies of applicable reference standards are not included in or bound with the Contract Documents. Where reference standards are needed for the Work, obtain such reference standards(s) from the publication source.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 45 33

CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contractor responsibilities for code-required Special Inspections and testing.
2. Special Inspection program and reporting requirements.
3. Attachment A to this Section includes requirements for submittal of Special Inspections.
4. Attachment B to this Section includes Special Inspector qualifications, reporting requirements, and material specific Special Inspections and tests.
   a. Attachments A and B are for the Contractor's reference only and are not part of the Contract Documents.
   b. Attachments A and B are included to assist Contractor in understanding the Owner-provided services so the effect of such services may be factored into the Contractor's pricing and Progress Schedule.
   c. The Testing Agency and Special Inspector(s) performing the Owner-furnished services will be identified following the Effective Date of the Contract, unless otherwise identified in Section 01 11 00 - Summary of Work.

B. Purpose:

1. This Section and its attachments were developed to address the requirements of the 2015 edition of the International Building Code, IBC section 1704.1 and applicable amendments, if any, by authorities having jurisdiction.
   a. One or more Special Inspectors will be retained by Owner or Owner's consultant to perform Special Inspections on the types of Work addressed by the applicable building code under Section 1704.
2. One or more Special Inspectors or Testing Agencies will be retained by Owner or Owner's consultant to perform Special Inspections and tests for the types of Work indicated in the building code.
3. A Statement of Special Inspections will be submitted to the Owner as a condition for issuance of applicable permit. This statement is included as Attachment A to this Section. Attachment B indicates a complete list of materials and Work requiring Special Inspections, required Special Inspections and the minimum qualifications of the Testing Agencies and Special Inspectors.
4. Special Inspections performed by entities retained by Owner or an entity for whom Owner is responsible are for benefit of Owner, Engineer, RDPRC, and Building Code Official. Contractor, together with Subcontractors and Suppliers, are not intended beneficiary of Special Inspections.

C. Related Requirements: Include, but are not necessarily limited to, the following:

1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
4. Section 04 22 00 - Concrete Masonry.
5. Section 05 12 00 - Structural Steel.
6. Section 05 50 00 - Metal Fabrications.
7. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
8. Section 31 23 05 - Excavation and Fill.
9. Section 31 23 33 - Trenching and Backfilling.

1.2 REFERENCES

A. Definitions:

1. The following defined terms, indicated in this section with initial capital letters, have the meaning assigned below, which apply to the singular and plural thereof:
   a. “Registered Design Professional in Responsible Charge” (RDPRC) means the licensed and registered design professional who is responsible for reviewing and coordinating submittal documents prepared by others, including phased and deferred submittal items, for compatibility with the design of the facility.
   b. “Soils Engineer” or “Geotechnical Engineer” means a Special Inspector engaged for the specific purpose of performing specialized Special Inspections relative to subgrade conditions, fill, special foundations, or a combination of these. “Soils Engineer” or “Geotechnical Engineer”, when used relative to Special Inspections, is an entity separate from Engineer. Relative to the Division 31 Specifications, for the purposes of Special Inspection "Soils Engineer," "Geotechnical Engineer," and "Special Inspector" have the same meaning.
   c. “Special Inspections” means inspection of specific elements of the Work requiring the expertise of an approved special inspector for compliance with the building code and the Contract Documents. Elements requiring special inspection are identified within this Section or elsewhere in the Contract Documents. Materials, mechanical, performance, and other testing required by the contract in other Specification sections, but not listed in this Section, are not part of the special inspections program.
   d. “Special Inspector” means representative of the Owner approved inspection entity designated for that portion of the Work.
   e. “Statement of Special Inspections” means document provided to the Building Code Official outlining special inspections and tests to be done on the Project and frequency of required tests.
   f. “Testing Agency” means approved entity, not affiliated with or hired by the Contractor, and responsible for the materials testing requirements of the Project including but not limited to concrete cylinder breaks, soils testing, and masonry materials testing. Testing Agency does not include any testing entity or laboratory retained by Contractor, Subcontractor, or Supplier either for tests that are Contractor’s responsibility in accordance with the Contract Documents but are not required by the building code, or test performed for Contractor’s convenience and information.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Meetings:

1. Attend and participate in preconstruction conference to review and coordinate responsibilities for inspection and testing procedures and requirements, as well as other preconstruction conference topics indicated in Section 01 31 19 - Project Meetings. Relative to this Section, in addition to required attendees indicated in Section 01 31 19 - Project Meetings, required conference attendees include:, Testing Agency and Special Inspectors, , Engineer, and Contractor, together with appropriate Subcontractors and Suppliers.
2. Attend and participate in construction progress meetings prepared to discuss matters related to coordination and cooperation with Testing Agency and Special Inspectors, defective Work, and other topics indicated for construction progress meetings in Section 01 31 - Project Meetings.

1.4 CONTRACTOR’S RESPONSIBILITIES REGARDING SPECIAL INSPECTIONS

A. Contractor’s Responsibilities Regarding Special Inspections – General.

1. Coordinate and cooperate with Testing Agency personnel, Special Inspectors, and employees and agents of Building Code Official.
2. Provide means to obtain and handle samples taken on site.

3. Provide storage facilities for testing agencies exclusive use as described in the Contract Documents.
4. Special Inspection is Owner's independent quality control. Special Inspections do not, in any way, reduce or mitigate Contractor's responsibilities for quality assurance, quality control, workmanship, complying with the Contract Documents, correction period or warranties. Contractor's own personnel shall review all Work requiring Special Inspections for compliance with the Contract prior to calling for the inspection.

B. Advising Testing Agency and Special Inspectors of Need for Services:

1. Not less than 24 hours prior to the need for Special Inspection or code-required testing or sampling, advise Testing Agency of Special Inspector, as applicable, in writing of Work for which Special Inspections or testing is required, indicating approximate time the Work will be ready for such inspection, testing, or sampling.
2. When Special Inspection, testing, or sampling is necessary on a Monday or day following a holiday, furnish such written advisory not less than the prior business day.

C. Work for which Special Inspections are required shall remain accessible and exposed for the purposes of Special Inspections until completion of required Special Inspections.

D. Work to be inspected shall be complete at time of Testing Agency's or Special Inspector's, as applicable, arrival at the Site.

E. Work that is defective shall be corrected and re-inspected. Such portions of the Work shall not be covered or concealed until authorized by Engineer.

1.5 REPORTING DUTIES AND AUTHORITY

A. Reporting:

1. Testing Agency and Special Inspectors will furnish to RDPRC and Engineer written results of Special Inspections promptly after performance of such tests and inspections. When acceptable results are indicated, Contractor may obtain copies thereof from Engineer.
2. Reporting of Defective Work:
   a. Testing Agency and Special Inspectors will report defective Work to Contractor, Engineer, and RDPRC promptly.
   b. Defective Work that has been covered up or concealed prior to re-inspection will be reported by RPDRC to Engineer and Building Code Official.

B. Limitations on Authority of Special Inspectors and Testing Agencies:

1. Special Inspector and Testing Agencies expressly do not have authority for:
   a. Ordering, stopping, or suspending the Work.
   b. Modifying the requirements of the Contract Documents.
   c. Accepting defective Work.
   d. Directing the Contractor's, means, methods, techniques, sequences, or procedures of construction.
   e. Directing or advising on Contractor's safety programs or measures for safety and protection.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. Attachments: The following, bound after this Section's "End of Section" designation, are furnished for Contractor's reference but are expressly not part of the Contract Documents.

1. Attachment A - Submittal of Special Inspections, (one page).

2. Attachment B - Special Inspections, Inspector Qualifications and Reporting Requirements, (five pages).

END OF SECTION

ATTACHMENT A TO SECTION 01 45 33

SUBMITTAL OF SPECIAL INSPECTIONS

Statement Date: _____

Project Name: _____
Site Address: _____
Owner: _____
Registered Design Professional in Responsible Charge (RDPRC): _____

The Statement of Special Inspections (Statement) is submitted as a condition for permit issuance in accordance with the Special Inspection requirements of the building code. The Special Inspection program is outlined in Specifications Section 01 45 33 – Code-Required Special Inspections and Procedures, including its Attachments A and B. A detailed explanation of the requirements for Special Inspections and Testing are indicated in Specifications Section 01 45 33 in conjunction with Specifications for each material and construction work result governed by the applicable building code.

Monthly Special Inspection reports will be submitted to the RDPRC and the Building Code Official. Apparent defective Work will be brought to the immediate attention of the Contractor for correction. If the defective Work is not corrected, the defective Work will be brought to the attention of the RDPRC and Engineer. Only documents that are prepared and signed or sealed by the Special Inspectors (SI) are valid.

The SI is responsible for verifying all information on each document prior to signing or sealing and directly forwarding it to the RDPRC and Engineer. The RDPRC will furnish to Owner results of Special Inspections indicating acceptable results, unless Owner directs that reports indicating unacceptable results also be furnished to the Owner. The SI is responsible for verifying all inspectors under its supervision maintain current, valid certifications for the duration of the Project's construction. At the conclusion of each individual Special Inspection type, the SI will complete a Final Report.

The Special Inspection program does not relieve the Contractor or any other entity of any contractual duties, including quality control, quality assurance, or safety and protection. The Contractor is solely responsible for construction means, methods, techniques, procedures and sequences and associated safety and protection, and for complying with the Contract Documents. Failure to comply with the SI program as outlined herein may result in a stop work notice being issued by the Building Code Official.

Respectfully submitted,
Design Professional in Responsible Charge,

_____
Type or Print Name

_____License # _____
Expires: _____

_____ _____
Signature Date

END OF ATTACHMENT A

ATTACHMENT B TO SECTION 01 45 33

SPECIAL INSPECTIONS, INSPECTOR QUALIFICATIONS AND REPORTING REQUIREMENTS

PART 1 - GENERAL

1.1 QUALIFICATIONS

A. Qualifications stated here are the minimum recommended by the RDPRC.

B. All Special Inspections and testing will be done under the direction of a professional engineer or registered architect licensed and registered in the State of Idaho herein referred to as Registered Professional for Special Inspections (RPSI), who will be employed by or retained by Testing Agency or other entity furnishing Special Inspectors.

C. Soil, concrete, masonry, mortar, grout, steel and aluminum related testing.

1. The Testing Agency shall have a minimum of 10 years experience in the testing of the materials indicated.
2. The Testing Agency's technician(s) performing such testing:
   a. Shall have a minimum of five years experience in the testing of soil, concrete, mortar, grout, steel and aluminum as appropriate.
3. Concrete Related Work:
   a. International Code Council certification for Reinforced Concrete and American Concrete Institute Concrete Field Testing Technician – Grade 1.

D. Structural Special Inspections:

1. Professional engineers or architects, licensed and registered in the State of Idaho, may perform Special Inspections in accordance with their licensure.
2. Other individuals, working under the direct supervision of a licensed, registered, professional engineer or architect and possessing the following qualifications, may perform Special Inspections.
3. Soils Related Work:
   a. NICET Level II Certification in geotechnical engineering technology/construction; or
   b. Professional geologist licensed and registered in the same jurisdiction as the Site; or
   c. Engineer intern, also known as an Engineer in Training (EIT) (i.e., a person who has successfully passed the EIT exam that is part of the overall process of becoming a licensed, registered professional engineer, serving under the direct supervision of professional engineer licensed and registered in the same jurisdiction as the Site).
4. Concrete Related Work:
   a. International Code Council certification for Reinforced Concrete Special Inspector or American Concrete Institute Concrete Construction Special Inspector.
   b. Alternatively, may be an engineer intern/EIT under the direct supervision of a professional engineer licensed and registered in the same jurisdiction as the Site.
5. Precast Concrete Erection Related Work:
   a. Engineer intern/EIT under the direct supervision of a professional engineer licensed and registered in the same jurisdiction as the Site.
   b. Welding:
      1) American Welding Society as a Certified Welding Inspector; or
      2) International Code Council Structural Steel and Welding Certification and American Welding Society Qualified and one year of related experience; or
      3) Non-Destructive Testing (NDT) Level II or III Certificate (for non-destructive testing only).
6. Masonry Related Work:

a. Will be certified by the International Code Council or American Concrete Institute for structural masonry and possess not less than one year of related experience.
b. Alternatively, may be an engineer intern/EIT possessing not less than two years' of appropriate training, relevant experience, or a combination thereof.

7. Steel and Aluminum Related Work:
   a. Frame and material verification Section 1705.2 of the applicable building code:
   b. Welding:
      1) American Welding Society as a Certified Welding Inspector; or
      2) International Code Council Structural Steel and Welding Certification and American Welding Society Qualified and possessing not less than one year of related experience; or
      3) Non-Destructive Testing (NDT) Level II or III Certificate (for non-destructive testing only).
   c. High strength bolting:
      1) International Code Council Structural Steel and Welding Certification and possessing not less than one year of related experience.
      2) Alternatively, may be an engineer intern/EIT with appropriate training and experience.
8. Firestopping Related Work:
   a. International Firestop Council Certification and possessing not less than two years of related experience; or
   b. International Code Council Certification and possessing not less than two years of related experience; or
   c. Intertek's Qualified Personnel (IQP) Program and possessing not less than two years of related experience.
9. Other equivalent certifications are unacceptable unless approved by Engineer.

1.2 REPORTING DUTIES AND AUTHORITY

A. Reporting requirements for Special Inspector in accordance with the applicable building code for Building System Related Work.
   1. Comply with requirements of applicable building code Section 1704.2.4.
   2. Provide written documentation of all inspections and testing, including results, performed by Testing Agency and Special Inspectors.
      a. Indicate exact location of the subject Work.
      b. If testing of specimens is performed, include detailed information on storage and curing of specimens prior to testing.
   3. Furnish inspection and test reports to Contractor, RDPRC, and Engineer.
      a. Expressly indicate whether the Work inspected was performed in accordance with the Contract Documents.
      b. Immediately report defective Work to Contractor, RDPRC, and Engineer.
      c. If the defective Work is not remedied promptly, notify RDPRC and Engineer.
   4. Issue a report, as an Electronic Document, summarizing all inspections, corrective action notifications and resolution of defective Work every 14 days.
      a. Furnish reports to:
         1) Engineer's project manager.
         2) Owner.
         3) Building Code Official.
         4) Contractor.
   5. Prior to requesting inspection for Substantial Completion, the RDPRC shall compile all test reports for each inspected material and work result for each Special Inspector and

summarize in a single Electronic Document (as a PDF file) and submit to Engineer and Building Code Official.

a. Final summary report shall be sealed and signed by the RDPRC, who shall be licensed and registered in the same jurisdiction as the Site for Special Inspections stating:

1) The required Special Inspections have been performed.

2) All defective Work has been remedied to comply with the Contract Documents except as specifically indicated in the summary report.

B. Special Inspector shall report all defective Work to Contractor, RDPRC, and Engineer promptly.

1. Defective Work that has been covered up or concealed prior to re-inspection shall be reported to Engineer and RDPRC.

C. Special Inspector does not have authority to order stopping or suspending the Work or modify the requirements of the Contract Documents.

1.3 MATERIAL SPECIFIC SPECIAL INSPECTIONS AND TESTS

A. Material specific requirements for Special Inspection and testing are indicated in the Specifications listed below. Special Inspection and testing requirements are indicated in the associated Specifications section under "Source Quality Control", "Field Quality Control" or "Quality Assurance" as appropriate for each material.

1.4 SOILS

A. Special Inspections will be performed in accordance with applicable building code Section 1705.6 as required to determine that subgrades were prepared in accordance with the Contract Documents, and to verify the allowable soil bearing pressure, materials, compaction densities, trenching and backfill and compliance with the Contract Documents.

B. Inspection and testing requirements are indicated separately in the Division 31 Specifications and are indicated as being performed by the Geotechnical Engineer, Testing Agency, or Special Inspector.

1.5 CONCRETE

A. Special Inspection and testing will be performed in accordance with applicable building code 1.7.6.6. Inspection is required for material verification, reinforcing steel size and layout, reinforcing steel mechanical splices, embedded bolts, concrete tests, concrete placement and curing, and waterstop installation.

B. Inspection and testing requirements are indicated in Specifications Section 03 05 05 - Concrete Testing and Inspection, and Specifications Section 03 31 31 - Concrete Mixing, Jointing, Placing and Curing, and are indicated as the services to be performed by the Special Inspector or Testing Agency.

1.6 MASONRY

A. Special Inspections and testing will be performed in accordance with applicable building code. .. Inspection is required for material tests and verification, reinforcing steel, embedded bolts and anchorages, grouting, and welding of reinforcing.

B. Inspection and testing requirements are indicated in Specifications Section 04 22 00 – Concrete Masonry, and are indicated as the responsibility of the Special Inspector.

1.7 STEEL, STAINLESS STEEL, AND ALUMINUM

A. Special Inspections will be performed for structural steel and aluminum in accordance with applicable building code. Inspection is required for material verification, high-strength bolting, welding and other Work shown or indicated in the Contract Documents.

B. Inspection and testing requirements are indicated in Specifications Section 05 12 00 - Structural Steel and Section 05 50 00 - Metal Fabrications, and are indicated as the responsibility of the Special Inspector. Inspection requirements are applicable to aluminum, stainless steel, and structural steel.

C. Inspection and testing requirements of cold-formed steel are required only when connections are made by welding.

D. Inspection of erection and permanent bracing is required only for cold formed trusses spanning greater than 60 feet.

1.8 EXTERIOR FINISH AND INSULATION SYSTEM (EIFS)

A. Special Inspections will be performed in accordance with applicable building code.

1.9 FIRESTOPPING (FIRE-RESISTIVE PENETRATIONS AND JOINTS)

A. Special Inspection will be performed in accordance with applicable building code as required to verify that through-penetration firestopping and joint firestopping were installed in accordance with the Contract Documents.

END OF ATTACHMENT B

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SECTION 01 51 05
TEMPORARY UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temporary electricity.
2. Temporary lighting.
3. Temporary communications.
4. Temporary heating, cooling, ventilating, and temporary enclosures.
5. Temporary water supply.
6. Temporary sanitary facilities.
7. Temporary first-aid facilities.
8. Temporary fire protection.

B. Scope:

1. Contractor shall provide all temporary utilities and temporary facilities required for the Project, including those indicated in this Specifications section.
2. Make all arrangements with utility owners for temporary utilities and with others as appropriate for temporary facilities. Obtain required permits and approvals for temporary utilities and temporary facilities.
3. Pay all service costs for utilities and facilities indicated in this Specifications section as Contractor's responsibility, including cost of electricity, water, fuel, and other utility services and temporary facilities required for the Work.
4. Continuously maintain adequate temporary utilities and temporary facilities for all purposes for the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities and temporary facilities through Substantial Completion and removal of temporary field offices and sheds unless otherwise approved in writing by Engineer.
5. Should Owner occupy part of the Work prior to Substantial Completion of the entire Work, cost of utilities consumed via temporary utilities serving the portion occupied by Owner will be shared proportionately by Owner and Contractor as mutually agreed to by the parties.
6. Maintain, including cleaning, temporary utilities and temporary facilities, and continuously provide consumables as necessary.
7. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and the needs of the Project.
8. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and requirements of authorities having jurisdiction and, when applicable, requirements of utility owners.

1.2 REQUIREMENTS FOR TEMPORARY UTILITIES AND TEMPORARY FACILITIES

A. Temporary Electricity:

1. Provide temporary electric service necessary for the Work, including continuous power for temporary field offices and sheds. Provide temporary outlets with circuit breaker protection and ground fault protection.
2. Temporary Electricity for Work in Existing Buildings:
   a. Contractor may use existing 120 V convenience receptacles in Owner's existing building spaces for items such as small hand tools. Contractor need not sub-meter or reimburse Owner for use of existing 120 V service.

B. Temporary Lighting:

1. Provide temporary lighting at the Site of not less than the greater of (1) Laws and Regulations, and (2) the following:
   a. Five foot-candles for open areas, 10 foot-candles for shops 25 foot-candles for stairs.
   b. Provide not less than one, 300 W lamp every 15 feet in indoor work areas.
   c. Where temporary lighting is required in office or laboratory areas occupied by Owner or facility manager: 40 foot-candles at a height of 2.5 feet above the finished floor.
   d. Night Security Lighting: Five foot-candles within 50 feet of all parts of the Site during hours of darkness, controlled by photocell.
2. Do not work in areas with insufficient lighting. Where lighting is insufficient for the work activities to be performed, provide additional temporary lighting.
3. Provide temporary lighting sufficient for observation of the Work by Engineer and inspection by Contractor, entities performing code-required tests and special inspections, and authorities having jurisdiction. Where required by Engineer, provide additional temporary lighting.
4. Provide temporary lighting for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

C. Temporary Communications:

1. Provide temporary telephone service and communications for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

D. Temporary Heating, Cooling, Ventilating, and Enclosures:

1. Provide sufficient temporary heating, cooling, and ventilating and temporary enclosures to ensure safe working conditions and prevent damage to existing property and the Work.
2. Except where otherwise specified, temporary heating shall maintain temperature of the space served between 50 degrees F and maximum design temperature of building or facility and its contents.
3. Required temperature range for storage areas and certain elements of the Work, including preparation of materials and surfaces, installation or application, and curing as applicable, shall be in accordance with the Contract Documents for the associated Work and the Supplier's recommended temperature and humidity ranges for storage, application, or installation, as appropriate.
4. Provide temporary ventilation sufficient to prevent accumulation in construction areas and areas occupied by Owner or facility manager of hazardous and nuisance levels or concentrations of dust and particulates, mist, fumes, vapors, odors, and gases, associated with construction. Similarly, provide temporary ventilation for building or structure spaces temporarily without ventilation due to the Work.
5. Temporary Enclosures:
   a. Provide temporary enclosures and partitions required to maintain required temperature and humidity.
   b. Temporary enclosures shall be sufficiently sturdy and durable for the intended use and duration. Maintain and repair temporary enclosures as necessary.
6. Provide temporary heating, cooling, and ventilating for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

E. Temporary Water:

1. General:
   a. Provide temporary water service and facilities including piping, valves, meters if not provided by owner of existing waterline, backflow preventers, pressure regulators, and other appurtenances. Provide freeze-protection as necessary to prevent freezing of temporary services.

b. Continuously maintain adequate water flow and pressure for all purposes during the Project, until removal of temporary water systems.

2. Water for Construction Purposes:
   a. Provide water for Site maintenance and cleaning and, water necessary for construction activities, and water for disinfecting and testing of systems.
3. Water for Human Consumption and Sanitation:
   a. Provide potable water in accordance with Laws and Regulations for consumption by personnel at the Site, for field offices, and for sanitary facilities.
   b. When necessary, provide bottled, potable water for use and consumption by personnel at the Site, including Contractor, Engineer, and visitors to the Site.
   c. Provide temporary water for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

F. Temporary Sanitary Facilities:
1. Provide suitably-enclosed chemical or self-contained toilets for Contractor's employees, Subcontractors, Suppliers, Engineer, and visitors to the Site. Location of temporary toilets shall be acceptable to Owner and Engineer.
2. Refer to Paragraph 1.2.E of this Specification Section for requirements for temporary water service intended for human consumption during construction.
3. Provide suitable temporary washing facilities for employees and visitors.
4. Provide temporary sanitary facilities for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

G. Temporary First-aid Facilities.
1. Provide temporary first-aid stations at or immediately adjacent to the Site's work areas, and inside Contractor's field office. Locations of temporary first-aid stations shall be determined by Contractor's safety representative. Replenish supplies in first-aid stations as items are used, prior to expiration of items, and as necessary. Monitor and log inventory of supplies in temporary first-aid stations [not less than once per week].
2. Provide list of emergency telephone numbers at each hardwired telephone at the Site.
3. Provide temporary first-aid facilities for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

H. Temporary Fire Protection.
1. Provide temporary fire protection in accordance with Laws and Regulations and the requirements of this Specifications section.
2. For work areas without standpipe fire protection systems, during construction provide portable fire extinguishers rated not less than 2A or 5B in accordance with NFPA 10 – Portable Fire Extinguishers, for each temporary building and for every 3,000 square feet of floor area under construction.
3. Provide Class A (ordinary combustibles), Class B (combustible liquids and gases), and Class C (electrical equipment) fire extinguishers as necessary.
4. Comply with NFPA 241 – Standard for Safeguarding Construction, Alternation, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.
5. Provide temporary fire protection for Engineer's field office in accordance with Section 01 52 11 - Engineer's Field Office.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for temporary utilities and temporary facilities:
1. may be new or used but, if used, shall be in good condition;

2. shall be adequate for purposes intended;
3. shall not create unsafe or unsanitary conditions; and
4. shall comply with Laws and Regulations.

B. Provide required materials, equipment, and facilities, including piping, cabling, supports, controls, and appurtenances.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install temporary utilities and temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.

B. Location of Temporary Utilities and Temporary Facilities:

1. Locate temporary systems for proper function and service.
2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility owners and others.
3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.

C. Modify and extend temporary systems as required by progress of the Work.

3.2 USE

A. Maintain temporary systems to provide safe, continuous service as necessary and as required.

B. Properly supervise operation of temporary systems:

1. Enforce compliance with Laws and Regulations.
2. Enforce safe practices.
3. Prevent abuse of services.
4. Prevent nuisances and hazards caused by temporary systems and their use.
5. Prevent damage to finishes.
6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.

C. At end of each workday, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient for continuous operation.

3.3 REMOVAL

A. Completely remove temporary utilities, temporary facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not otherwise specified, restore to preconstruction condition.

B. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner. If utility owner will perform such work, coordinate with and pay utility owner for such work.

C. Where permanent utilities and systems were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

END OF SECTION

SECTION 01 52 11
ENGINEER'S FIELD OFFICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Engineer's field office at the Site, provided by Contractor, including:
   a. Physical requirements for field office and related site improvements.
   b. Utilities, environmental controls, and similar services for field office.
   c. Furniture and furnishings for field office.
   d. Equipment for field office.
   e. Maintenance, cleaning, and supplies.
   f. Removal of field office and associated restoration.

B. Scope:

1. Contractor shall provide temporary field office, with furniture, furnishings, equipment, services, consumables, and other requirements of this Section, for Engineer's sole use during the Project's construction.
2. Engineer's field office shall be complete and fully functional within 30 days of the date the Contract Times start to run.
3. Obtain and pay for required permits and utilities.

C. Related Requirements:

1. Section 01 51 05 - Temporary Utilities.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with Owner, facility manager (if other than Owner), other contractors, and others using the Site, location of Engineer's field office and related temporary facilities.
2. The office shall be located close to the Contractor's field office, at a spot approved by the Engineer.

1.3 SUBMITTALS

A. Action Submittals: Obtain Engineer's approval of the following prior to installing Engineer's field office at the Site and prior to obtaining furniture, furnishings, and equipment required by this Section:

1. Field Office Submittal: Submit all of the following as one Submittal which shall include:
   a. Site plan indicating proposed location of Engineer's field office, parking for Engineer's field office, facilities related to Engineer's field office, and material of both field office parking and sidewalk or walkway to Engineer's field office.
   b. Layout and Physical Attributes Shop Drawings of Engineer's Field Office:
      1) Information on proposed field office size, construction, exterior appearance, interior finishes, and field office security measures.
      2) Proposed layout of interior of Engineer's field office, showing location of offices, common areas, restroom, closet, other areas required (if any), with dimensions indicated for each. Show locations of interior partition walls, doors (including direction of opening), and windows.
   c. Exterior Sign Shop Drawing:
      1) Indication of size, material, and thickness of exterior sign for Engineer's field office.

2) Proposed layout of field office exterior sign, showing all text, font, character sizes, colors, and graphics (if any).

d. Utilities:

1) Proposed type of internet service; name of proposed internet service provider; and product data and technical information on equipment required for internet service.

e. Furniture and Furnishings: Product data and technical information for:

1) Desks.
2) Chairs (desk chairs, office chairs, folding chairs).
3) Tables.
4) File cabinets and storage cabinet.
5) Racks.
6) Field office safety items and equipment required in this Section.

f. Equipment: Product data and technical information for:

1) Copier-printer-scanner.
2) Speaker phone for conference area.
3) Coffee maker.
4) Other equipment required in this Section.

PART 2 - PRODUCTS

2.1 FIELD OFFICE CONSTRUCTION AND SITE REQUIREMENTS

A. Site Requirements at Field Office:

1. Vehicle Parking:

a. Allocate total of two reserved parking spaces for use by Engineer and Owner in close proximity to Engineer's field office.

b. Vehicle parking spaces shall be not less than nine feet wide.

c. Parking area shall be paved with crushed stone, asphalt concrete, concrete, or other material approved by Engineer.

d. Provide parking area with safe layout, suitable for vehicle entry to temporary or permanent travelled ways, as applicable, with sufficient space for reasonable vehicle maneuvering.

e. Parking area shall be properly drained and free of standing water during wet weather.

2. Walkway or Sidewalk to Field Office Entrance:

a. Provide sidewalk or walkway, not less than four feet wide, of crushed stone, asphalt concrete, concrete, or other material approved by Engineer.

b. Provide sidewalk or walkway for full distance between parking area and entrance to Engineer's field office.

B. Minimum Construction for Engineer's Field Office: Provide Engineer's field office in accordance with the following:

1. Structurally sound foundation and superstructure.
2. Size: Floor area of not less than 300 square feet, and not less than 10 feet wide, with clear vertical distance of eight feet between interior floor and ceiling.
3. Completely weathertight and insulated, with not less than R-19 insulation.
4. Exterior finish approved by Engineer.
5. Interior finishes shall be new or in like-new condition, approved by Engineer, including wood paneling (or other acceptable finishing) on walls and resilient flooring in first-class condition.
6. Field Office Ingress and Egress:

a. Provide two doors for ingress and egress for each field office unit, each with landing, stairs, and railing complying with applicable building code and other Laws and Regulations in effect at the Site.
b. Landing and stairs shall have slip-resistant walking surfaces, and be metal, pressure-treated lumber, fiberglass, or concrete.
c. Railing shall be metal, pressure-treated lumber, or fiberglass.

7. Physical Security:
   a. Doors shall be secure and lockable with cylinder-type locks. Padlocks are unacceptable.
8. Windows:
   a. Window area equal to not less than 10 percent of floor area.
   b. Provide each window with insect screen (unless other type of screen is required) and operable sash.
   c. Provide each window with lock approved by Engineer, in addition to other physical security features required, if any.
9. One lockable closet for storage.
10. Keys:
    a. Furnish to Engineer two identical sets of keys suitable for operating all keyed locks, including ingress/egress door locks, security bars (when required) for doors and windows, window locks, closet(s), and lockable drawers on office furniture.
    b. Permanently and legibly label each key to indicate its associated lock.
11. Restroom:
    a. Provide private restroom in Engineer's field office, including one lavatory, one toilet, medicine cabinet with mirror, soap dispenser, and paper towel holder.
    b. Provide each restroom with appropriate electric ventilation fan with positive discharge to location outside the field office.
12. Exterior Sign for Engineer's Field Office:
    a. Provide exterior sign for Engineer's field office, approved by Engineer. Sign shall be durable, weatherproof, suitable for long-term exposure to sunlight, precipitation, wind, windborne grit, and other local atmospheric elements.
    b. Exterior sign shall be not less than three feet high by four feet wide, installed at location determined by Engineer at the Site.
    c. Sign shall be in color, as presented in the layout below.
    d. Sign layout and general proportions shall be as presented below. Text of first line and last line shall be Arial font. Text size and size of graphic shall be proportionate to the layout below. Engineer will furnish to Contractor Electronic Documents file(s) of Engineer's "third party logo package" for use in preparing the sign, together with Engineer's standard, published instructions on use of Engineer's logo. Contractor shall comply with Engineer's written instructions for using Engineer's logo.

ENGINEER'S FIELD OFFICE

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C. Optional Construction for Engineer's Field Office:

1. In lieu of providing Engineer's field office in a fixed structure, provide mobile office trailer(s), either new or used (if used, in good condition), approved by Engineer. Mobile field office trailer(s) shall be, specifically designed for use as construction site field office and complying with requirements of this Section.
2. Provide skirting (between bottom of trailer to ground) around perimeter of each mobile field office trailer.
3. Supplier: Subject to compliance with the Contract Documents, provide Engineer's field office by one of the following:
   a. Pac-Van division of United Rentals.
   b. WillScot Modular Space Solutions.
   c. Or equal.

2.2 UTILITIES AND ENVIRONMENTAL CONTROLS FOR FIELD OFFICE

A. Utilities for Engineer's Field Office – General:

1. Comply with Section 01 51 05 - Temporary Utilities.
2. Should actions of utility owner(s) delay completion of Engineer's field office, Contractor shall provide temporary electricity, heat, water, sanitary facilities, and communications service as necessary at no additional cost to Owner.

B. Provide the following for Engineer's field office:

1. Electrical System and Lighting:
   a. Electric service as required, including paying all costs. Provide electrical submeter if electric service is obtained from Owner's system.
   b. Electrical systems shall comply with Laws and Regulations.
   c. System suitable for 120/240 volt AC, single phase, 60 Hertz service. Provide 120-volt AC, single-phase, 60 Hertz power to convenience receptacles in Engineer's field office. Provide transformers and other materials and equipment as necessary.
   d. Electrical system components, including circuit breakers, cabling, convenience receptacles, switches, and lighting fixtures and luminaires, shall be Underwriters Laboratories, Inc. (UL) approved.
   e. Electric circuits shall be protected by circuit breakers. Fuses are unacceptable. Provide circuit breaker on incoming electric service to Engineer's field office.
   f. Not less than 13 wall-mounted, duplex convenience receptacles on interior of each structure comprising Engineer's field office. Provide four per room plus one in restroom.
   g. Appropriate strike plate for each wall switch and convenience receptacle.
   h. Interior lighting of not less than 100 foot-candles at desktop height.
   i. Exterior, wall-mounted lighting at each entrance to field office, not less than 250 watts (equivalent) each.
   j. Exterior security lighting for Engineer's field office's parking area. Provide one, 1,000-watt (equivalent), pole-mounted fixture with photocell control.
2. Heating, Ventilating, and Air Conditioning:
   a. Provide automatic heating to maintain indoor temperature in field office of not less than 70 degrees F in cold weather. Provide fuel and pay utility costs.
   b. Automatic cooling to maintain indoor temperature in field office of not greater than 75 degrees F in warm weather.
   c. Provide wall-mounted thermostat for controlling heating and air conditioning.
   d. Functioning ventilation system for field office with number of air changes in accordance with Laws and Regulations.

3. Water and Sewerage:
    a. Provide potable water service for each plumbing fixture associated with field office.
    b. Provide sanitary sewerage for each lavatory/sink and toilet in field office.
    c. Utility Connections – General:
        1) Comply with Laws and Regulations, including plumbing and sewer codes, and requirements of authorities having jurisdiction, including water and wastewater utility owners and operators.
        2) Protect plumbing from freezing.
    d. Potable Water Service: Provide the following:
        1) Appropriate copper waterline from potable water main to each plumbing fixture.
        2) Reduced pressure zone (RPZ)-type backflow preventer in accordance with Laws and Regulations and requirements of authorities having jurisdiction.
        3) Provide 15-gallon electric hot water tank or tankless hot water heater, and hot water piping to serve each lavatory/sink in field office.
        4) Not less than one exterior hose bib, with not less than 50 feet of hose, located adjacent to field office sidewalk or walkway, near field office ingress/egress doors. Provide wall-mounted hose reel or hose caddy.
        5) Before placing potable water system into service, disinfect piping and appurtenances in accordance with Laws and Regulations, and requirements of authorities having jurisdiction.
    e. Sanitary Sewerage:
        1) Provide PVC or other appropriate piping, arranged in accordance with Laws and Regulations, to convey wastewater from field office to sanitary sewer that discharges to one of the following: (1) permitted wastewater treatment facility, (2) onsite wastewater disposal system provided and operated in accordance with Laws and Regulations, or (3) onsite holding tank provided by Contractor.
        2) When holding tank is provided, also provide pumping and disposal of holding tank contents at appropriate, regular intervals. Dispose of holding tank contents in accordance with Laws and Regulations.
4. Internet Access:
    a. Obtain and pay for internet service until removal of Engineer's field office, with unlimited (untimed, unrestricted by data use) internet access, for Engineer's sole use.
    b. Set up system and appurtenances required and verify functionality in the field office. Engineer will establish router password and information technology security measures for Engineer's field office.
    c. Regardless of type of internet service provided, provide the following:
        1) Modem appropriate for internet service provided.
        2) Ethernet cabling between modem and router.
        3) Wireless Router, Product and Manufacturer: NETGEAR Orbi 6 Wifi Router; or Linksys Dual-Band Mesh WiFi 6 Router (MR9600); or equal.
        4) Modem, router, and cabling will remain Contractor's property upon removal of Engineer's field office,
    d. Internet service shall be one of the following, listed in order of preference, with most desirable type of service indicated first. Provide a lower type of service only when the next-preferred type of service is unavailable:
        1) Cable or Fiber-optic Service:
            a) Provide service via communication service provider via either cable or fiber-optic service at download speed of not less than 100 megabits per second (Mbps) and upload speed of not less than 25 Mbps.

2) Mobile Wireless Broadband Service:
   a) Provide mobile broadband wireless 5G network by AT&T, Verizon, T-Mobile, or equal, with download speed of not less than 75 Mbps and upload speed of not less than 25 Mbps.
   b) When 5G service is not available at the Site, provide mobile broadband wireless 4G network by AT&T, Verizon, T-Mobile, or equal, with download speed of not less than 37 Mbps and upload speed of not less than 17 Mbps.
3) DSL Service:
   a) Provide service via symmetrical digital subscriber line (DSL) with download speed of not less than 1.5 Mbps and upload speed of not less than 384 kilobits per second (Kbps).
   b) Provide dedicated telephone line for internet access.
   c) Provide DSL filters on each non-DSL outlet in Engineer's field office landline telephone system.
4) Satellite:
   a) Provide 5G network service with download speed of not less than 50 Mbps.
   b) Provide required equipment, including outdoor unit (dish) and cabling between dish and satellite modem.

5. Security System and Security Monitoring Service:
   a. Description:
      1) Provide for Engineer's field office fully installed, operational security monitoring and alarm system, to monitor for security breaches (break-ins) and fire at Engineer's field office.
      2) System shall monitor each ingress/egress door to exterior and each window in field office.
   b. Materials and Equipment:
      1) Provide equipment by a recognized security monitoring entity regularly engaged in the business of providing security monitoring systems and services for business enterprises in the locality of the Site.
      2) Provide one user interface (keypad) at main ingress/egress door of each separate structure comprising Engineer's field office.
      3) Provide audible and visual alarms in the event of security breach or fire.
      4) Cabling for security monitoring system shall be interior to Engineer's field office and protected from disabling by unauthorized persons. Cabling shall comply with Laws and Regulations and requirements of security monitoring system provider.
      5) System components shall be UL-listed.
   c. Security Monitoring Services:
      1) Provide professional security monitoring service 24 hours per day, 365 days per year, until removal of Engineer's field office from the Site. Security monitoring system shall be active and fully operational before Engineer occupies Engineer's field office.
      2) In event of alarm condition, system shall automatically activate both audible and visual alarms and shall automatically summon police and fire services, as applicable.
      3) Engineer will program access code for security system for Engineer's field office.

2.3 FURNITURE AND FURNISHINGS FOR FIELD OFFICE

A. Furniture: Provide in Engineer's field office at the Site the following furniture:

1. Desks: Two 5-drawer desks, each with desktop surface five feet long by 2.5 feet wide, with not less than one file drawer per desk, suitable for storing 8.5-inch by 11-inch documents.

When Engineer's field office is mobile trailer-type structure, built-in desks are acceptable when required drawers are provided.

2. Chairs:
   a. Desk Chairs: Two new or used (in good condition) five-point, high backed, cushioned swivel chairs with seat-height adjustment. Chairs without wheels or with torn or holed cushions, backs, or arms are unacceptable.
   b. Folding Chairs: 8 sturdy metal folding chairs without arm rests.
3. Tables:
   a. Two new or used (in good condition) folding tables, each eight feet long by 2.5 feet wide.
   b. Two new or used (in good condition) folding tables, each four feet long by 2.5 feet wide.
4. Drawing Racks: One drawing rack(s), each capable of holding not less than threefull-sized paper sets of the Drawings.
5. Storage Cabinet: One 2-door storage cabinet.
6. Shelving or Bookcase: Provide not less than 12 feet of shelf length, not less than 12 inches deep.

B. Furnishings: Provide in Engineer's field office at the Site the following furnishings:

1. Ingress/Egress Furnishings: Provide the following at each ingress/egress to and from Engineer's field office:
   a. Door mats of suitable size and texture.
   b. Boot scraper.
2. Window Coverings: Operable blinds sized for each window in Engineer's field office.
3. Office Waste Receptacles:
   a. Three polyethylene waste baskets, each with capacity of not less than seven gallons.
4. Clock: One electric, wall-mounted clock, not less than 10 inches diameter.
5. Wall-Mounted Furnishings: Installed by Contractor at locations indicated by Engineer's field office personnel:
   a. One cork tack-boards, each approximately 2.5 feet by three feet, with thumbtacks.
   b. One white board for use with dry markers (four colors), approximately six feet by three feet, with marker holding tray. Furnish supply of colored markers and eraser for white board.
6. Safety Equipment for Field Office:
   a. Provide for each separate structure comprising Engineer's field office the following, in accordance with Laws and Regulations and manufacturer's published instructions:
      1) One wall-mounted, 10-pound ABC dry powder fire extinguisher, upright and fully charged, in an easily accessible location, with signage.
      2) Ceiling-mounted smoke detectors with supply of batteries for each.
      3) Carbon monoxide detector with power supply.
   b. Provide the following for Engineer's field office, regardless of the quantity of structures comprising field office:
      1) One ANSI/ISEA Z308.1, Class B first aid kit, Type III or Type IV, in weatherproof case, for Engineer's sole use.
      2) One OSHA, "Employee Right to Know" Poster, prominently displayed.
      3) One automatic external defibrillator (AED) kit, rescue-ready, in appropriate, wall-mounted cabinet (installed by Contractor at location approved by Engineer) with "AED" signage. Product and Manufacturer: Zoll AED Plus, or equal. Upon removal of Engineer's field office from the Site, defibrillator and accessories shall remain Contractor's property.

7. Miscellaneous Office Items: Furnish the following for Engineer's use:
    a. One three-hole punch, Master Products Series 25, or equal.
    b. One stapler, Swingline 113, or equal.
    c. One Scotch tape dispenser(s).
    d. Two wire "in"/"out" baskets.
    e. Upon removal of Engineer's field office from the Site, miscellaneous office items shall remain Contractor's property.

2.4 EQUIPMENT FOR FIELD OFFICE

A. Provide the following equipment for Engineer's field office:

1. Copier-Printer-Scanner (Inkjet, Basic):
    a. Description: Furnish one inkjet copier-printer-scanner with color printing capability.
    b. Manufacturer and Product: Furnish from among the following:
        1) Brother MFC-J4535DW INKvestment Tank All-in-One Color Inkjet Printer with NFC, Duplex and Wireless Printing
        2) Canon PIXMA TS Series All-in-One Color Wireless Bluetooth Inkjet Printer.
        3) Or equal.
    c. Sheet Size: Capable of printing 8.5-inch by 11-inch, 8.5-inch by 14-inch, and 11-inch by 17-inch sheets.
    d. Printing Speed: 20 pages per minute (black and white), 18 pages per minute (color).
    e. Scanning: Capable of scanning to PDF and JPG files, selectable by the user.
    f. Ink Cartridges: Provide all cartridges required for full-color printing, and promptly replace cartridges as needed until removal of Engineer's field office from the Site.
    g. Upon removal of Engineer's field office from the Site, copier-printer-scanner will become Owner's property.
2. Speaker Phone for Conference Area:
    a. Description: Furnish speaker phone for conference area in Engineer's field office. Speaker phone shall be suitable for use with computer conferencing platforms such as Zoom, Microsoft Teams, Cisco WebEx, and Google Meetings, without connecting to telephone landline.
    b. Manufacturer and Product: Jounvo JV801 USB Speakerphone; or equal.
    c. Equipment:
        1) Intelligent noise cancelation.
        2) Microphone: 15-foot pickup radius.
        3) Speaker: Adjustable volume control.
        4) Connection: USB or Bluetooth connection to computer.
    d. Accessories:
        1) Provide with cables necessary for operation.
    e. Upon removal of Engineer's field office from the Site, conference area speaker phone shall become Owner's property.
3. Temperature and Humidity Monitor:
    a. Provide temperature and humidity monitor for Engineer's field office, with sensor installed outdoors in shade and approximately five feet above ground, and display installed inside Engineer's field office.
    b. Manufacturer and Product: Provide Fisher Scientific "Traceable Remote Alarm RH/Temperature Monitor" (Catalog No. 14-649-84); or equal.
    c. Unit shall display daily minimum and maximum temperature and current temperature, and be capable of displaying daily minimum and maximum relative humidity and current relative humidity, and have audible alarm and adjustable alarm setpoints.

4. Water Cooler and Potable Water Supply:
    a. Provide five-gallon bottled water with electric cooler dispenser.
    b. Provide supply of potable, bottled water suitable for dispenser for duration of Project, together with supply of disposable cups.
5. Coffee Maker:
    a. One electric coffee maker, with ten-cup capacity or larger.
    b. For duration of Project, furnish coffee supplies, including coffee (ground), filters, sugar and alternative sweetener, creamer, stir sticks, and disposable cups.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location:

1. Locate Engineer's field office in accordance with Section 01 14 19 - Use of Site, other relevant provisions of the Contract Documents, and decisions made during site mobilization discussions at the preconstruction conference.
2. Provide Engineer's field office nearby Contractor's field office.
3. Location of Engineer's field office shall be acceptable to Engineer.

B. Preparation:

1. Prepare the site where Engineer's field office will be installed as necessary and required by the Contract Documents. Minimize extent of site disturbance for Engineer's field office. Where site preparation for Engineer's field office results in disturbance of existing ground cover, comply with Laws and Regulations, required permits, and requirements of the Contract Documents regarding soil disturbances and temporary erosion and sediment controls.
2. Provide firm, compacted subgrade for Engineer's temporary field office.
3. Provide temporary utilities in accordance with Section 01 51 05 - Temporary Utilities, and requirements of utility owner.

C. Installation:

1. Install Engineer's temporary field office and related facilities in accordance with Laws and Regulations. Install Engineer's field office level and in structurally sound manner.
2. Install materials and equipment, including prefabricated structures, in accordance with manufacturer's instructions.
3. Verify operation of all systems, including electrical power supply to lighting and convenience receptacles in field office; proper operation of field office's heating, ventilating, and air conditioning system; proper plumbing with freeze protection (where necessary); and proper operation of all other equipment provided by Contractor for Engineer's field office.
4. Install in Engineer's field office furniture, furnishings, equipment, and appurtenances required in this Section. Install at locations directed by or otherwise acceptable to Engineer.
5. Remove from Engineer's field office packing materials and boxes for furniture, furnishings, and equipment.
6. Where furniture, furnishings, and equipment provided by Contractor will become Owner's property, temporarily store original packaging and boxes for such items and deliver such items to Owner in such boxes and packaging, where appropriate.

3.2 MAINTENANCE, CLEANING, AND SUPPLIES

A. Maintenance Services: Provide the following maintenance services for Engineer's field office, from establishment of field office until its removal:

1. Maintenance and Repairs:
    a. Immediately and properly remedy malfunctioning, damaged, leaking, or defective field office structure, site improvements, systems, and equipment.

b. Provide supplies for Engineer's field office electronic equipment. Arrange and pay for maintenance on Contractor-furnished electronic equipment, including copier.

c. Promptly provide snow and ice removal for Engineer's field office, including vehicle parking area, walkways, and stairs and landings.

2. Cleaning:

a. Provide continuous maintenance of and janitorial service for Engineer's field office and sanitary facilities.

b. Clean only when Engineer's employee or representative is present in Engineer's field office.

c. Clean Engineer's field office not less than once per week. During weekly cleaning, clean windows of Engineer's field office inside and out and vacuum clean window blinds. Sweep or vacuum-clean (while minimizing airborne dust) Engineer's field office's floors not less than each weekday, or more frequently when site conditions are such that dirt or mud is frequently tracked into Engineer's field office.

d. Clean and wax (as appropriate) flooring every six months.

3. Waste Disposal:

a. Properly dispose of trash and waste as needed, not less than twice per week.

b. Properly handle and dispose of recyclables. Do not dispose of recyclables as trash.

c. Dispose of other waste, if any, as necessary and required, to avoid creation of nuisances and adverse environmental effects. Properly dispose of electronic waste, when necessary, at proper waste receiving facility.

d. Dispose of waste from Engineer's field office in accordance with Laws and Regulations.

B. Consumables: Provide the following consumables as needed:

1. Toner and ink cartridges for copiers and printers, as required.
2. Paper supplies for copiers and printers. Always maintain in Engineer's field office not less than one ream of each size of paper for which copiers and printers are capable.
3. Dry markers in four colors, and white board eraser set. Replace markers when exhausted or misplaced.
4. Paper towels, anti-bacterial liquid soap, toilet tissue, and cleaning supplies for field office restroom.
5. Bottled water suitable for water cooler. and disposable cups.
6. Coffee supplies, including coffee, filters, cups, sugar, alternative sweetener(s), creamer, and stir-sticks.
7. Batteries for smoke detectors and other battery-powered items furnished by Contractor.
8. Replace fire extinguishers upon expiration.
9. Supply of disposable ear plugs for visitors.
10. Not less-often than monthly, inspect first-aid kit and inventory items consumed or used and remove items at or near their expiration date. Promptly replace and restock consumed and expired items.

3.3 REMOVAL AND RESTORATION

A. Removal:

1. Do not remove Engineer's field office until after Substantial Completion of the entire Work, unless otherwise approved by Engineer.
2. On date acceptable to Engineer, fully remove Engineer's field office and restore areas prior to final inspection.
3. When required by the Contract Documents to deliver to Owner or facility manager certain equipment provided for Engineer's field office, carefully remove such items, return to original boxes, and deliver to Owner or facility manager (as applicable) at location indicated by Owner or facility manager. Deliver such items complete with all accessories and manufacturer's operation and maintenance instructions.

B. Restoration:

1. Restore areas occupied by Engineer's field office and related facilities. Restore areas damaged or disturbed during installation, maintenance, and removal of Engineer's field office and related facilities.
2. Restore to condition in accordance with the Contract Documents. If not expressly required otherwise, restore to preconstruction condition.
3. Restore subject to approval of the owner of affected property. Remedy damage in accordance with Section 01 71 33 - Protection of the Work and Property, and other provisions of the Contract Documents.

END OF SECTION

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SECTION 01 52 13
CONTRACTOR'S FIELD OFFICE AND SHEDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for:
   a. Contractor’s field office at the Site.
   b. Contractor’s storage and work sheds.
   c. Maintenance and removal of Contractor’s field offices and sheds and associated restoration.

B. Scope:

1. Contractor shall provide temporary field office for Contractor’s use during the Work.
2. Provide required temporary storage and work sheds.
3. Obtain and pay for required permits and utilities.

C. Related Requirements:

1. Section 01 11 00 - Summary of Work.
2. Section 01 51 05 - Temporary Utilities.
3. Section 01 71 33 - Protection of the Work and Property.
4. Section 01 78 39 - Project Record Documents.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate with Owner, facility manager (if other than Owner), other contractors, and others using the Site, location of field offices and sheds, including contracts and projects indicated in Section 01 11 00 – Summary of Work.

B. Staffing:

1. Not less than one Contractor staff member shall be reasonably present at, or in reasonable proximity to, Contractor’s field office during normal working hours when work is in progress.
2. When Contractor’s staff are absent from, and not within reasonable proximity to, Contractor’s field office, provide clearly legible sign, each entrance to Contractor’s field office, indicating specific location onsite of Contractor’s site superintendent, together with (a) valid mobile phone number of Contractor’s site superintendent, and (b) Contractor's 24-hour emergency contact telephone number.

PART 2 - PRODUCTS

2.1 CONTRACTOR’S FIELD OFFICE

A. Structure:.

1. Provide for Contractor’s field office structurally sound, weathertight, temporary structures in good condition, complying with Laws and Regulations, and suitable for the intended purpose and environment.
2. Where field office and sheds will be occupied, whether regularly or on an interim basis, comply with Laws and Regulations governing accessibility, egress, fire detection and prevention, and other Laws and Regulations related to health and safety.

3. Size and layout of Contractor's temporary field office and sheds to be determined by Contractor and appropriate for Contractor's purposes and sufficient in size (12 personnel) for Owner and Engineer coordination meetings.

B. Temporary Utilities and Related Items – Materials and Equipment:

1. Provide materials and equipment for temporary utilities, temporary lighting, temporary control of temperature and ventilation, temporary fire protection, temporary sanitary facilities, and temporary first-aid facilities, in accordance with Section 01 51 05 – Temporary Utilities.

C. Furnishings and Equipment:

1. Sign for Field Office:
   a. Provide on exterior of Contractor's field office, at location plainly visible for visitors, an identification sign displaying Contractor's company name.
   b. Maximum size of sign shall be four feet by three feet.
   c. Provide highly-visible, plainly legible, text on contrasting background color.
   d. Sign shall be suitable for outdoor use for the duration of the Project.
2. Conference Facilities:
   a. Provide in Contractor's field office conference area with conference table and chairs sufficient for 10 people, unless Contractor requires greater space and furniture for Contractor's purposes.
3. Provide other furnishings and equipment deemed necessary and appropriate by Contractor.
4. Personal Protective Equipment for Use by Visitors:
   a. Furnish and maintain at Contractor's field office 10 protective helmets ('hard hats" and other, appropriate personal protective equipment deemed necessary by Contractor, for use by visitors to the Site.

2.2 CONTRACTOR'S STORAGE SHEDS AND WORK SHEDS

A. Storage and Work Sheds – General:

1. Provide storage and work sheds sized, furnished, and equipped to accommodate personnel, materials, and equipment used in the Work, including temporary utility services and facilities necessary for environment and sufficient for personnel, materials, and equipment.
2. Provide in accordance with Laws and Regulations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Location:

1. Locate Contractor's field office and sheds in in staging area identified in the Contract Documents, and decisions made during site mobilization discussions at the preconstruction conference.

B. Installation:

1. Install Contractor's temporary field office, sheds, and related facilities in accordance with Laws and Regulations.
2. Install materials and equipment, including prefabricated structures, in accordance with manufacturer's instructions.
3. Provide temporary utilities in accordance with Section 01 51 05 – Temporary Utilities, and requirements of utility owner.

3.2 MAINTENANCE

A. Clean and maintain field offices and sheds as necessary.

B. Provide consumables as necessary.

3.3 REMOVAL AND RESTORATION

A. Removal:

1. Do not remove temporary field offices and sheds until after Substantial Completion of the entire Work, unless otherwise approved by Engineer.
2. Fully remove field offices and sheds and restore areas prior to final inspection.

B. Restoration:

1. Restore to preconstruction conditions areas damaged by Contractor while installing and using temporary field offices and sheds, subject to approval of the owner of affected property. Remedy damage in accordance with Section 01 71 33 - Protection of the Work and Property, and other provisions of the Contract Documents.

END OF SECTION

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SECTION 01 57 05
TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for temporary controls during construction, including:
   a. Temporary erosion and sediment controls.
   b. Noise control.
   c. Dust control.
   d. Temporary pest and rodent controls.
   e. Water control, including storm water, surface water, and groundwater.
   f. Pollution control, including solid waste, water pollution, atmospheric pollution, and other types of pollution.
   g. Odor control.

B. Scope:

1. Contractor shall provide and maintain materials, equipment, labor, services, and temporary construction as necessary and required to control environmental conditions at the Site and adjacent areas during construction.
2. Contractor shall pay all costs, including fines and civil penalties, if any, for failure to implement and maintain temporary controls in accordance with the Contract Documents and Laws and Regulations. Contractor is not eligible for increase in Contract Price or Contract Times due to failure to comply with requirements for temporary controls.
3. Maintain temporary controls until no longer necessary or required. Provide temporary controls at all times when Contractor is working at the Site.

C. Related Requirements:

1. Include, but are not necessarily limited to, the following:
2. Section 01 74 00 - Cleaning.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable provisions and recommendations of the following:
   a. Section 404 of the Clean Water Act

1.3 SUBMITTALS

A. Action Submittals:

1. Submit the following:
   a. Shop Drawings:
      1) Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a site plan approximate areas of planned disturbance of soils and soil cover over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that Contractor proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional areas.
      2) Location and details of each temporary settlement basin.
   b. Product Data:
      1) Silt fencing materials.

2) Other materials proposed for temporary erosion and sediment controls, when requested by Engineer.

B. Informational Submittals:

1. Submit the following:

a. Procedural Submittals:

1) Proposed dust control measure, when Submittal is requested by Engineer.

b. Field Quality Control:

1) When requested by Engineer, promptly obtain and submit results of field measurements and field test data substantiating compliance of Contractor's temporary controls with the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Drawings.

PART 3 - EXECUTION

3.1 NOISE CONTROL

A. Noise Control – General:

1. Contractor's vehicles, construction equipment, and machinery shall minimize noise emissions to greatest degree practicable. When necessary, provide mufflers and silencers on construction equipment, machinery, and vehicles, and provide temporary sound barriers sound-absorbing blankets, sound-reducing enclosures, modified backup alarms, and other mitigation measures when necessary.
2. Noise threshold levels shall comply with Laws and Regulations, including (a) OSHA requirements and recommendations, and (b) local ordinances or other Laws or Regulations.
3. Noise emissions shall not interfere with the work of Owner, facility manager (if other than Owner), or others. The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning and emergency purposes only.
4. Music or entertainment systems, including personal and vehicle radios, media players, and the like, when used, shall not be audible at the property line and shall not disturb others at the Site.
5. Field Quality Control of Noise:

a. If Owner or Engineer believes potential exists that allowable noise levels are being exceeded, Contractor will be required to, and shall promptly perform, appropriate noise monitoring in presence of Owner or Engineer and shall submit written results to Engineer.

b. Owner and Engineer reserve the right to perform independent noise monitoring at any time during the Work.

6. If noise level exceeds allowable maximum, Contractor shall immediately cease the activity emitting the excessive noise and promptly implement noise-mitigating measures to comply with noise limitations.

3.2 DUST CONTROL

A. Dust Control – General:

1. Control objectionable dust caused by Contractor's operation of vehicles and construction equipment and machinery, site clearing, demolition, cleaning, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of Engineer and approval of authorities having jurisdiction.

2. Contractor shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce onsite and off-Site damage, inconvenience, nuisances, and health hazards associated with dust emissions from Contractor's activities.

B. Dust Control Methods:

1. Dust control may be accomplished by irrigation in which the dust-prone work activity or area of the Site is sprinkled with water until the surface is moist.
2. Apply dust controls as frequently as necessary or required without creating inconveniences, nuisances, or hazards, such as excessive mud and ponding of water at or adjacent to the Site. Do not use water for dust control when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
3. Provide dust control that is non-polluting and does not contribute to tracking-out of dirt, mud, and dust onto pavement.
4. Do not allow water used for dust control to discharge to storm water drainage system or surface waters.
5. Where appropriate, reduce travel speed of construction vehicles and construction equipment to reduce the potential for dust emissions arising from vehicle and equipment passage.
6. Where appropriate, apply gravel or other appropriate binder to access roads and parking areas.

C. Removal of Dust and Dirt from Pavement and Other Travelled Ways:

1. Remove dust, mud, and dirt from roads, parking areas, and other travelled ways not less than the frequency indicated in Section 01 74 00 - Cleaning.
2. Perform dust and dirt removal from travelled ways by mechanical wet vacuum sweeping or other method acceptable to Engineer.
3. Remove mud from roads, parking areas, and other travelled ways by appropriate means, including scraping. Avoid damaging surface of travelled way. Remedy damage to roads, parking areas, and travelled ways resulting from mud removal activities.

D. Removal of Dust and Dirt from Buildings and Structures:

1. When dust and dirt from Contractor's activities has accumulated to a noticeable or objectionable extent (compared with preconstruction conditions) on buildings or structures, remove the dust and dirt caused by Contractor's operations by appropriate methods, including power-washing using mild detergent. Remedy damage caused by dust, dirt, and power-washing.
2. Dust in sensitive equipment, such as electrical and control panels, instruments, HVAC systems and other equipment shall be cleaned by a Subcontractor specializing in cleaning such items.
3. During the Project, remove objectionable and noticeable dust, dirt, and mud in areas occupied by Owner or facility manager, and Contractor's work areas, resulting from Contractor's activities. Owner and facility manager will take reasonable measures to avoid tracking dust, dirt, and mud into their occupied areas.
4. Comply with Section 01 74 00 - Cleaning.

3.3 PEST AND RODENT CONTROL

A. Pest and Rodent Control – General:

1. Provide pest and rodent controls as necessary to prevent infestation of the Site, storage areas, and adjacent areas.
2. 2. Pests and rodents include, but are not limited to: flies, mosquitoes, gnats, midges, stinging insects, other insects and the like, worms, rats, mice, moles, voles, and similar animals, raccoons, skunks, objectionable numbers and species of birds, and others.
3. Implement appropriate pest and rodent controls when pests, rodents, or both are apparent at the Site or offsite storage, staging, or laydown areas.

4. Control or remove pests and rodents from adjacent properties when Contractor's activities have fostered or exacerbated pest or rodent problems. For example, ground vibration, such as that associated with horizontal directional drilling, may cause migrations of subterranean animals such as moles and voles. Coordinate with affected property owners regarding appropriate control methods, materials, equipment, and disposal techniques.

B. Methods, Materials, and Equipment for Pest and Rodent Control during Construction:

1. Employ methods and use materials and equipment for pest and rodent control that do not adversely affect conditions at the Site or on adjacent and nearby properties.
2. Do not use control methods or poisons injurious to household pets or animals other than targeted pests and rodents.
3. Avoid control methods that present hazards to humans, including children.

C. Disposal of Pests and Rodents:

1. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled. Do not bury or dispose of deceased animals at the Site or in adjacent areas.

3.4 WATER CONTROL

A. Water Control – General:

1. During the Project. provide methods to appropriately control storm water, surface water, water from excavations and structures, groundwater flows altered by Contractor's activities, and groundwater discharges from the Site, to prevent damage to the Work, the Site, adjacent properties, and downstream properties.
2. Control trenching, filling, and grading to direct water away from excavations, pits, tunnels and other construction areas, and prevent water from entering existing buildings and structures.
3. Properly manage and control storm water, surface water, and groundwater entering the Site from upstream, where such flows or discharges have potential to affect the Work or to be exacerbated by Contractor's activities.
4. Avoid ponding of water onsite, except in specially-designated, temporary settlement basins. Where water ponding occurs during construction, perform rough grading to eliminate ponding.
5. Prevent water from discharging onto roads, parking areas, paved or finished areas, and other travelled ways. Prevent storm water runoff from discharging across access roads and parking areas.

B. Materials, Equipment, and Facilities for Water Control:

1. Provide, operate, and maintain materials, equipment, and facilities of adequate size, materials, and capacity to control storm water, surface water, groundwater, and discharges from tanks.

C. Discharge and Disposal of Water during Construction:

1. Discharge storm water, surface water, and groundwater from the Site, and discharges of clean water from tanks, to proper discharge locations, in accordance with Laws and Regulations and the Contract Documents.
2. Prevent damage and nuisances arising from water discharges on the Site and discharges from the Site.
3. Dispose of water in manner that avoids flooding, erosion, sediment transport, and other damage, in accordance with Laws and Regulations.
4. Avoid overland discharges from the Site and construction activities to adjacent properties,
5. Water discharges from the Site and construction activities shall be via a storm water drainage route or conduit with sufficient capacity for the flow under associated weather and flow conditions and in accordance with requirements of authorities having jurisdiction

6. Do not discharge storm water, surface water, groundwater, or clean water from tanks, into sanitary sewers. Obtain consent of sewerage system owner before discharging such flows into existing combined sewers.
7. Obtain sewerage system owner's consent and approval before discharging polluted water to sewerage system.

3.5 POLLUTION CONTROL

A. Pollution Control – General:

1. Provide means, methods, and facilities necessary and required to prevent contamination of soil, water, and atmosphere caused by accumulation or discharge of substances and materials that are either noxious, polluting, or both, from or caused by construction and related activities.
2. Construction equipment and machinery shall comply with Laws and Regulations.

B. Spills and Contamination:

1. Perform emergency containment, cleanup, and remedy of spills and contamination resulting from construction and related activities. Promptly remove and properly dispose of contaminated soils and liquids.
2. Excavate contaminated material and properly dispose of off-Site, and replace with suitable compacted fill and appropriate cover.

C. Protection of Surface Water and Groundwater:

1. Provide and maintain appropriate, temporary measures to prevent harmful substances from entering surface water, groundwater, and drinking water. Prevent disposal of wastes, effluents, chemicals, and the like into or adjacent to groundwater, surface water, drainage routes (including swales, ditches, and storm sewers) and drinking water.
2. Obtain sewerage system owner's consent and approval prior to discharging into sanitary sewers or combined sewers. Do not discharge pollutants not in accordance with Laws and Regulations into combined sewers, or sewers tributary to combined sewers, when wet weather overflows to receiving waters may occur.

D. Atmospheric Pollutants:

1. Provide and maintain temporary controls for atmospheric pollutants resulting from construction and related activities, whether to outdoor or indoor atmospheres.
2. Prevent harmful dispersal of pollutants into atmosphere.
3. Do not discharge exhaust from internal combustion engines or combustion operations into buildings, structures, or near ventilation intakes for buildings or structures.
4. Prevent toxic and noxious concentrations of chemicals, fumes, and vapors.

E. Solid Waste:

1. Provide and maintain temporary controls for managing solid waste related to the Work.
2. Prevent solid waste from:
   a. Becoming airborne or blowing in the wind.
   b. Being inadvertently transmitted to adjacent, offsite properties, and areas of the Site not part of the Project.
   c. Being deposited in or discharging to surface waters, and drainage routes.
3. Properly handle and dispose of solid waste. Burning or burying solid waste, including unused materials, at the Site or adjacent areas is prohibited.
4. Cleaning and Disposal of Debris: Comply with applicable requirements of the General Conditions, as may be modified by the Supplementary Conditions, and Section 01 74 00 - Cleaning.
5. Do not mix or store in the same container solid waste containing Constituents of Concern (and constitutes, or may constitute, a Hazardous Environmental Condition) with solid waste that does not contain Constituents of Concern.

6. Store solid waste in appropriate, covered, containers.
7. Promptly, and at regular intervals, remove solid waste from the Site for transport and disposal in accordance with Laws and Regulations.

3.6 ODOR CONTROL DURING CONSTRUCTION

A. Odors – General:

1. Avoid discharges of unpleasant or noxious odors from construction and related activities. Whether nature of the Work is such that odor generation is unavoidable, provide appropriate temporary controls for odors.
2. Give priority to avoiding odor generation, followed by:
   a. Counteracting (treating the cause of) odors.
   b. Containing odors.
   c. Odor masking as the last resort for odor control.

3.7 EROSION AND SEDIMENT CONTROLS

A. Installation and Maintenance of Temporary Erosion and Sediment Controls – General:

1. General Provisions:
   a. Provide temporary erosion and sediment controls as shown and indicated on the Drawings and as indicated in this Section and elsewhere in the Contract Documents, and as necessary for compliance with Laws and Regulations.
   b. Provide erosion and sediment controls as the Work progresses into areas where ground cover was previously undisturbed.
   c. Use necessary and required methods to appropriately control erosion and sediment transport in storm water runoff, including using soil conservation-oriented construction practices (including scheduling and sequencing), vegetative measures, and temporary physical controls.
   d. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in this Section‘s “Quality Assurance” Article (unless more-stringent requirement are shown or indicated in the Contract Documents), to control erosion and sediment transport in storm water runoff during the Project.
   e. Plan and execute disturbances of soils and soil cover, and earthwork by methods to control storm water runoff from exposed soil (including stockpiles, borrow areas, and spoil disposal areas), banks of surface waters affected by the Work, and discharges of groundwater, to prevent erosion and sediment transport.
   f. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provide measures for regulating storm water discharges and controlling erosion and sediment transport. Where Owner is a co-permittee with Contractor for applicable permits, or when plans for temporary erosion and sediment controls were sealed and signed by Engineer, such methods are subject to Engineer’s approval or acceptance, as applicable.
   g. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.
2. Coordination:
   a. Coordinate temporary erosion and sediment controls with this Section's requirements on water control .
   b. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities, permanent erosion controls and soil stabilization (if any), and other Work, to the extent necessary for effective and continuous erosion and sediment controls.
3. Before commencing activities that will disturb soil or soil cover at the Site or other areas to be occupied by Contractor during the Project, provide all appropriate temporary erosion and sediment controls required by the Contract Documents for the areas where soil or soil cover will be disturbed.

4. Vegetation Removal and Disturbance:
    a. Remove only those shrubs, grasses, trees, and other vegetation that must be removed for construction.
    b. Protect undisturbed vegetation. Do not wantonly or unnecessarily drive construction vehicles and equipment over undisturbed vegetation and soil cover.
    c. Promptly stabilize exposed soil where vegetation or soil cover was unnecessarily disturbed. Fill and restore ruts and damage to vegetation and soil cover caused by wanton or unnecessary passage of construction vehicles and equipment.
5. Access Roads and Parking Areas:
    a. When possible, locate and construct temporary access roads and parking areas to avoid adverse effects on the environment.
    b. Provide measures to regulate drainage, avoid erosion and sediment transport in storm water runoff, and minimize damage to vegetation and soil cover.
6. Earthwork and Temporary Controls:
    a. Perform excavation, fill, and related activities in accordance with Section 31 00 00 - Earthwork 31 23 05 - Excavation and fill 31 23 33 – Utilities - Trenching and Backfilling.
    b. Temporary erosion and sediment control measures may include, but are not limited to, using berms, swales and ditches, silt fencing, straw bale sediment barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible soils and other erodible materials exposed by construction activities.
    c. Minimize areas of bare soil exposed at one time. Provide fills and spoil areas by selectively placing fill and spoil materials to reduce or eliminate exposed erodible soils.
    d. Exercise special care on and above steep slopes, where disturbance of vegetation and soil cover shall be minimized to greatest extent reasonably practicable.
    e. Protect stockpile storage not in active use by providing suitable, durable covering prevent sediment transport in storm water runoff and windblown transport. Covering shall be suitable for outdoor exposure.
7. Inspection and Maintenance:
    a. Periodically inspect areas of non-stabilized, erodible soils, including all areas of soil cover disturbance and stockpiles, for evidence of start of erosion and sediment transport. Promptly implement corrective action as necessary and appropriate to control erosion and sediment transport. Continue inspections and corrective action until soils are permanently stabilized and permanent vegetation has been appropriately established.
    b. Inspect not less often than once per week and after each precipitation event of 0.5 inches of water or greater.
    c. Repair or replace damaged erosion and sediment controls within 24 hours of Contractor becoming aware of such damage.
    d. Periodically remove sediment that has accumulated in or behind sediment and erosion controls. Remove sediment not less often than when sediment is at approximately one-half of storage capacity of associated control element, unless more-frequent interval is indicated elsewhere in the Contract Documents. Properly dispose of sediment.
8. Duration of Temporary Erosion and Sediment Controls:
    a. Maintain temporary erosion and sediment controls in effective, working condition until soil cover of the associated storm water drainage area has been permanently stabilized.
9. Work Stoppage:
    a. If the Work is temporarily stopped or suspended for any reason, Contractor shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.

b. When temporary erosion and sediment controls remain in place during periods of stopped or suspended Work, continue to perform Contractor's obligations relative to periodic inspection and maintenance of temporary erosion and sediment controls, including removal of accumulated sediment.

10. Failure to Provide Adequate Temporary Erosion and Sediment Controls:

a. If Contractor repeatedly fails to satisfactorily control erosion and sediment transport in storm water runoff, Owner reserves the right to use Owner's own forces or employ a third-party contractors for temporary erosion and sediment control. Owner's costs for such work, including engineering and inspection costs, will be deducted from amounts due Contractor, as set-offs in accordance with the Contract Documents.

B. Fiber Wattle:

1. Provide and maintain fiber watter per ITD detal 212-3.

C. Straw Bale Dike.

1. Provide temporary straw bale dikes where shown or indicated and where necessary or required, including in swales, along contours, and along toe of slopes.
2. Provide temporary straw bales in shallow excavation as wide as the bale and approximately 4 to 6 inches below surrounding grade.
3. Ends of straw bales shall tightly abut ends of adjacent straw bales.
4. Securely install each straw bale using two support posts, driven into the ground not less than 1.5 to 2 feet below bottom of straw bale. Top of post shall be flush with top of straw bale. Angle first post for each straw bale toward the previously-installed straw bale.
5. Frequently inspect straw bales and repair or replace as required. Remove accumulated sediment and debris from behind straw bales.

D. Mulching and Soil Stabilization:

1. Use mulching to temporarily stabilize exposed soil, including spoil and fill materials.

a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.

b. Application of mulching for soil stabilization shall be as follows.

1) Non-Rotted Straw or Salt Hay: Provide 1.5 to two tons per acre.

2) Soil stabilization emulsions, when used, shall be applied in accordance with manufacturer's instructions, and shall be applied with mulch or stabilization fibers.

3) Wood-Fiber or Paper-Fiber Application: Provide 1,500 pounds per acre, installed by hydroseeding.

c. Where mats or netting are used:

1) Cover entire area to be stabilized with mats or netting.

2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, 4 inches or more wide, at top and bottom of slope. Ensure that mesh or netting is secure and will not wash out over time. Tamp trench full of soil. 4 inches from trench, secure mat or netting with appropriate staples at intervals of 10 inches.

3) Overlap adjacent strips of mat or netting by not less than 4 inches.

E. Protection of Storm Water Drainage Inlets and Catch Basins:

1. Protect each drainage inlet and catch basin that has potential to receive storm water runoff from exposed soils and does not discharge into a storm water settlement basin.
2. Provide temporary inlet filter bags inside of drainage inlet or catch basin in accordance with inlet filter bag manufacturer's instructions. Secure inlet filter bag with the structure's grate or by other acceptable means.

3. Inlet filter bags shall not pose any obstruction, above the preconstruction elevation of the drainage inlet or catch basin grate that would necessitate or require temporary barricades or warning lights.
4. When removing sediment from inlet filter bags, do not dump filter bag's contents into the drainage inlet or catch basin. Promptly remove from drainage inlets and catch basins sediment accidentally dumped into the structure.
5. Remove sediment from inlet filter bags, or replace inlet filter bags, when inlet filter bag is not more than half-full.

F. Temporary Settlement Basin:

1. For constructing embankments comply with requirements in Division 31 Specifications on embankments, excavation, and fill.
2. Overflow Weir and Discharge Pipe:
   a. Provide piping in accordance with manufacturer's instructions. Where permanent piping will be used for temporary settlement basin, provide piping in accordance with the Contract Documents and fully clean piping prior to Substantial Completion.
   b. Provide overflow weirs at elevation(s) shown or indicated on the Drawings. When not shown or indicated in the Contract Documents, discharge weir elevation(s) shall be in accordance with design by licensed, professional civil engineer retained by Contractor or Subcontractor. Such design and temporary construction shall avoid overtopping and overfilling of settlement basin without short-circuiting the settlement basin's hydraulic performance.
   c. Wrap and secure geotextile material specified for temporary silt fencing around discharge structures of temporary settlement basins
3. Crushed Stone and Riprap: Provide in accordance with Division 31 Specifications on excavation, fill, and riprap. Provide in areas of temporary settlement basin subject to erosion, and at upstream and downstream ends of each settlement basin’s discharge piping.
4. Remove sediment when necessary or required, based on accumulation of material.
5. When temporary settlement basin is no longer required, remove the temporary settlement basin discharge weir, discharge piping, and spillway, fill the temporary settlement basin to required grade in accordance with requirements of Division 31 Specifications on excavation and fill, and provide landscaping in accordance with the Contract Documents.

G. Temporary Stone Construction Entrance:

1. Where shown on the Drawings, and where construction vehicles will regularly transition to paved surfaces from unstabilized surfaces, provide temporary stone construction entrance. Contractor vehicles and mobile construction equipment and machinery shall use temporary stone construction entrances.
2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings, temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by 8 inches deep.
3. Installation:
   a. Ensure that subgrade under each temporary stone construction entrance is suitably dense for the intended purpose and dry. Suitably prepare subgrade as necessary for temporary stone construction entrance.
   b. Provide on subgrade a layer of geotextile separation fabric, installed in accordance with geotextile separation fabric manufacturer's recommendations for separation.
   c. Provide stone on installed geotextile separation fabric. Grade the stone for passage of vehicles.
4. Maintenance:
   a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.

b. When upper layer of temporary stone construction entrance becomes contaminated with soil, mud, or other material, remove the contaminated material and replace with clean stone.

c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is unacceptable.

3.8 REMOVAL OF TEMPORARY CONTROLS

A. Removals – General:

1. Unless otherwise indicated elsewhere in this Section in requirements for respective temporary controls, upon completion of the associated Work and when temporary controls are no longer necessary, remove temporary controls and restore the Site to condition in accordance with the Contract Documents; if condition is not shown or indicated, restore the Site to pre-construction condition.
2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

END OF SECTION

SECTION 01 57 20
ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section covers Contractor requirements for providing environmental controls and permits consistent with regulatory requirements throughout the duration of the project. If at any time the requirements herein are not being met, the BIA Representative may stop work. All work shall be completed in accordance with applicable permits and licenses.

1.2 RELATED SECTIONS

A. The following list of related specification sections is not intended to be all inclusive.

1. Section 01 14 00 – Work Restrictions
2. Section 01 33 00 – Submittal Procedures
3. Section 02 26 00 – Hazardous Materials Assessment
4. Section 02 41 00 - Demolition

1.3 REFERENCE STANDARDS

A. Public Law

1. Section 402 Clean Water Act (Public Law 92-500, as amended)

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00 – Submittals.

1.5 APPROVAL SUBMITTALS

A. 01 57 20-1, Spread of Noxious Weed Prevention

a. Description of methods used to prevent the spread of noxious weeds, including the location of inspection and washout station.

1.6 REGULATORY REQUIREMENTS

A. In cases of conflict, conform with the most stringent requirement.

1.7 LAWS, REGULATIONS, AND PERMITS:

A. Perform construction operations, including management of subcontractors, to comply, with: Applicable Federal, and local laws, orders, regulations, and water quality standards concerning control and abatement of water pollution; and terms and conditions of applicable permits issued by permit issuing authority.

1.8 CONTRACTOR VIOLATIONS:

A. Violation of applicable Federal or local laws, orders, regulations, or water quality standards may result in the BIA Representative stopping unrelated site activities until compliance is achieved.

B. The Contractor shall not be entitled to an extension of time, claim for damage, or additional compensation by reason of such a work stoppage.

1.9 REQUIRED PERMITS

A. None

1.10 CONTRACTOR RESPONSIBILITIES

A. Dust Control:

1. Prevent, control, and abate dust pollution during performance of work.

2. Provide labor, equipment, and materials, to prevent dust nuisance or damage to persons, property, or activities, including, but not limited to, crops, orchards, cultivated fields, wildlife habitats, dwellings and residences, agricultural activities, recreational activities, traffic, and similar conditions.

B. To reduce potential impacts to wildlife and vegetation in the project vicinity, boundary limits of construction are to be clearly marked in the field according to the Drawings.

C. In compliance with Executive Order 13112 regarding noxious weeds, the contractor shall inspect all earth-moving and hauling equipment at the contractor's equipment storage facility, and all equipment shall be washed prior to entering the construction site to prevent the introduction of noxious weed seed.

D. In compliance with Executive Order 13112 regarding invasive and noxious weeds, the contractor shall inspect all construction equipment and remove all attached plant/vegetation and soil/mud debris prior to leaving the construction site.

E. Erosion and Sediment Control:

1. Best Management Practices (BMP's) shall be implemented sufficiently to control erosion and prevent sediment from leaving the construction site.

F. Air Pollution Control

1. Use reasonably available methods and devices to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants.
2. Do not operate equipment and vehicles that produce excessive exhaust gas emissions.
3. Burning of waste materials is prohibited without specific authorization.

G. Water Quality

1. The Contractor shall adhere to all applicable tribal, state, and federal regulations when obtaining construction water.
2. Accepted best management practices should be implemented to ensure that all sediments and other pollutants are contained with the boundaries or the work area.
3. Equipment should be serviced and fueled off-site whenever practical. When vehicle servicing and fueling must occur on-site, select and designate an area at least 50 feet away from streams, canals, laterals, and riparian areas. Equipment staging areas should be at least 50 feet from downstream drainage facilities and watercourses unless otherwise stated in applicable permits.
4. Temporary structures, fills, and mats may be used as necessary.
5. After construction, temporary fills must be removed in their entirety and affected areas returned to pre-construction elevations.
6. Proper maintenance will be required during construction. This includes, but is not limited to, repair following severe storms or erosion events.
7. Equipment shall be operated in such a manner as to prevent materials from dumping or spilling into adjacent water bodies.
8. During construction, no petroleum products, chemicals, or other deleterious materials shall be allowed to enter the main canal or any adjacent waterways. Precautions shall be taken to prevent entry of these materials into the water.
9. Appropriate erosion control and siltation controls must be utilized and maintained throughout the construction process.
10. Stockpiling of materials is not allowed in flowing or standing water.
11. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows.
12. Temporary fills must be removed in their entirety and the affected areas returned to pre-construction elevations.
13. The areas affected by temporary fills must be revegetated, as appropriate.

H. Hazardous Materials

1. See Section 02 26 00 – Hazardous Materials Assessment for requirements for lead- or asbestos containing materials not previously sampled.
2. See Section 02 41 00 – Demolition for informational submittal requirements.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 CONSTRUCTION SITE MANAGEMENT

A. Contractor construction operations:

1. Perform construction activities by methods that will prevent entrance, or accidental spillage, of solid matter, contaminants, debris, or other pollutants or wastes into flowing or dry streams, lakes, canals, wetlands, reservoirs, or underground water sources.

B. Stockpiled or deposited materials:

1. Do not stockpile or deposit excavated materials or other construction materials, near or on, stream banks, lake shorelines, or other watercourse perimeters where they can be washed away by high water or storm runoff or can in any way encroach upon the watercourse.

C. Petroleum product storage tanks management:

1. oil or other petroleum product storage tanks at least 50 feet from streams, flowing or dry watercourses, lakes, canals, wetlands, reservoirs, and any other water source.
2. Do not use underground storage tanks.
3. Construct storage area containment dikes at least 12 inches high, or 1.5 times the volume of all containers therein and which is impervious to the materials contained therein for a minimum contact time of 72 hours, whichever is greater to permit safe containment of leaks and spills plus sufficient freeboard to contain the 25-year precipitation event.
   a. Line diked areas with an impermeable barrier at least 50 mils thick.
   b. Refueling operations: Conduct refueling operation in lined petroleum storage area. Cover refueling area with 2 to 4 inches of soil.

END OF SECTION

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SECTION 01 57 90

PRESERVATION OF ARCHAEOLOGICAL DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section identifies the requirements for the preservation of archaeological data associated with completion of the work defined in the Drawings and Specifications.

1.2 DEFINITIONS

A. Cultural Resources: Includes prehistoric, historic, architectural, and traditional cultural properties. These include, but are not limited to, human skeletal remains, archaeological artifacts, records, and material remains related to such property.

B. Cultural Items: Native American cultural items (i.e., funerary objects, sacred objects, objects of cultural patrimony, or human remains) for which protection is prescribed under the Native American Graves Protection and Repatriation Act (NAGPRA) - Public Law 101-601; 104 Stat. 3042, Section 3(d); and 43 CFR Part 10.4.

C. Human Remains: Physical remains of the body of a person.

D. Funerary Objects: Native American items that, as part of the death rite or ceremony of a culture, are reasonably believed to have been placed intentionally at the time of death or later with or near individual human remains.

E. Native American: Of, or relating to, a tribe, people, or culture that is indigenous to the United States.

F. Sacred Objects: Native American items that are specific ceremonial objects needed by traditional Native American religious leaders for the practice of traditional Native American religions by their present-day adherents. These items are specifically limited to objects that were devoted to a traditional Native American religious ceremony or ritual and which have religious significance or function in the continued observance or renewal of such ceremony.

G. Objects of Cultural Patrimony: Native American items having ongoing historical, traditional, or cultural importance central to the Indian tribe itself, rather than property owned by an individual tribal member. These objects are of such central importance that they may not be alienated, appropriated, or conveyed by any individual tribal member.

1.3 PROJECT CONDITIONS

A. An archeological survey of the project area has been performed by HDR, and there are no known cultural/archeological resources (items/features) within the limits of disturbance identified on the drawings. However, archeological, or culturally significant recourses may be encountered during construction.

B. Discovery of Resources:

1. Any Archeological or historical artifacts discovered during construction shall be left intact and undisturbed, all work in the area shall stop immediately, and the contractor shall immediately notify the BIA Representative who in turn will notify the BIA Northwestern Region Archaeologist (503.730.8457) and Shoshone-Bannock Cultural Resources Coordinator (208.478.3707) immediately pursuant to 36 CFR 800.13. Commencement of operations shall be allowed upon notification by the BIA Representative after notification from CRIT THPO and the BIA Western Region Office.
2. If during construction operations, any human remains, funerary objects, sacred objects, or objects of cultural patrimony, as defined in the native American Graves Protection and Repatriation Act (P.L. 101-601; Stat. 3048; 25 U.S.C. 3001), are discovered, the contractor shall cease operations in the immediate area of discovery, protect the remains and objects, and shall immediately notify the BIA Representative who in turn will notify BIA Northwestern Region Archaeologist (503.730.8457) and Shoshone-Bannock Cultural Resources

Coordinator (208.478.3707 of the discovery by telephone with written confirmation. The contractor shall continue to protect the immediate area of the discovery until notified by the BIA Representative who in turn will have been notified by BIA Regional Office and Shoshone-Bannock Cultural Resources Coordinator that operations may continue.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

SECTION 01 61 03
COMMON WORK RESULTS FOR EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Sections include but are not necessarily limited to:

1. Section 01 81 10 - Wind and Seismic Design Criteria.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 03 31 30 - Concrete, Materials and Proportioning.
4. Section 05 50 00 - Metal Fabrications.
5. Section 07 92 00 - Joint Sealants.
6. Section 09 96 00 - High Performance Industrial Coatings.
7. Section 10 14 00 - Identification Devices.
8. Section 26 05 09 - Motors.
9. Section 26 29 23 - Variable Frequency Drives - Low Voltage.
10. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
11. Section 40 61 13 - Process Control System General Requirements.
12. Section 40 67 00 - Control System Equipment Panels and Racks.
13. Section 40 73 00 - Pressure Instrumentation.
14. Section 46 21 12 – Inline canal traveling screens.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Bearing Manufacturers Association (ABMA).
2. American Gear Manufacturers Association (AGMA).
3. American Petroleum Institute
   a. API 686 - Recommended Practice for Machinery Installation and Installation Design
4. ASTM International (ASTM):
   a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.
   b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
5. Hydraulic Institute (HI):
   a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
6. International Electrotechnical Commission (IEC).
7. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
8. International Organization for Standardization (ISO):

a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.
b. 21940-11, Mechanical Vibration - Rotor Balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behavior.

9. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ICS 6, Enclosures for Industrial Control and System.
   c. MG 1, Motors and Generators.
10. InterNational Electrical Testing Association (NETA):
   a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
11. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC):
12. National Institute for Certification in Engineering Technologies (NICET).
13. National Institute of Standards and Technology (NIST).
14. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
15. Underwriters Laboratories, Inc. (UL).
   a. 508, Standard for Safety Industrial Control Equipment.
   b. 508A, Standard for Safety Industrial Control Panels.
   c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
16. Vibration Institute.

B. Supplier's Vibration Analyst:
   1. Supplier's vibration analyst shall prepare pre-Shop Drawing vibration analysis of equipment.
   2. Where required, Supplier's vibration analyst shall be either equipment manufacturer's qualified employee or independent business entity whose sole business, or principal part of its business, is evaluating and determining natural frequencies of rotating equipment.
   3. Shall possess not less than 10 years' relevant experience.
   4. Supplier's Vibration Analyst's Professional Engineer:
      a. Vibration analysis shall be performed by, or under the direct, personal supervision of, professional engineer experienced in preparing finite element analyses, rotordynamic analyses, and experimental modal analysis similar to that required for the Work.
      b. Professional engineer shall possess not less than five years' combined experience in field testing and data analysis for vibration analysis.
      c. Vibration analysis professional engineer's seal and signature, with indication of date seal and signature were applied to the subject document, shall clearly appear on all results and reports furnished as Submittals.

C. Field Vibration Testing Subcontractor:

1. Field vibration testing Subcontractor shall, where required by the Contract Documents, perform vibration testing of equipment installed at the Site and perform associated vibration analyses.
2. Vibration testing Subcontractor shall be an independent entity that has performed as its sole business, or principal part of its business, for not less than 10 years, inspection, testing, calibrating, adjusting equipment and systems, and performing vibration testing of equipment.
3. Entities whose principal business is one or more of the following are not considered independent vibration testing entities and, therefore, shall not be field vibration testing Subcontractor:
   a. Motor sales, service, or repairs.
   b. Process equipment sales, service, or repairs.
4. Acceptable entities include, but are not necessarily limited to::
   a. AVS Engineering: https://www.avsengineering.net/
   b. Engineering Testing Services: https://etestinc.com/
   c. Maritech, LLC: http://www.maritech-llc.com/contact.html
   d. Mechanical Solution, Inc. (MSI) www.mechsol.com
   e. Or equal.
5. Field vibration testing Subcontractor must have an established program for monitoring and testing equipment calibration, with accuracy traceable in an unbroken chain, in accordance with NIST requirements.
6. Field Personnel: Each person employed for field vibration testing on the Work shall possess not less than the following qualifications:
   a. Three years' field experience covering all phases of field vibration testing and data gathering.
   b. Current, valid Vibration Category II certification from Vibration Institute or a licensed, registered professional engineer who need not be licensed and registered in the same jurisdiction as the Site.
7. Analysis Personnel: Personnel performing analysis for field vibration testing Subcontractor shall possess not less than the following qualifications:
   a. Five years' combined field testing and data analysis experience.
   b. Current, valid Vibration Category III certification from the Vibration Institute or a professional engineer.
8. Analysis Equipment: Field vibration testing Subcontractor shall have access to and use, where appropriate, the following testing equipment, properly maintained and calibrated:
   a. Impact Hammer:
      1) Frequency Range: 1 kHz.
      2) Range (5v output) 5,000 pounds-force (22,200 newtons).
      3) Hammer sensitivity (approx.) 1mV/lbf (0.23 mV/N)
   b. Analyzer:
      1) Frequency Range: 1 Hz to 10,000Hz.
      2) Frequency Accuracy: 0.02 percent.
      3) Non-Integrated Spectral Amplitude Accuracy: 5 percent, 3 Hz to 65 Hz.
      4) Single Integrated Spectral Amplitude Accuracy: 5 percent, 10 Hz to 20 Hz.
      5) Supports measurements of acceleration, velocity, and displacement.
   c. Vibration Sensor:

1) Sensitivity: ±5 percent = 100 mV/g
2) Acceleration Range: ±5 g.
3) Amplitude Nonlinearity: ±1 percent
4) Frequency Response: ±10Hz to 7kHz (±3 dB)

d. Data logging equipment for simultaneous recording of the following data points:
1) Vibration in the X, Y, and axial planes (for all pumps pursuant to ANSI/HI Standard).
2) Digital tachometer recording RPM.
3) Discharge Pressure Transmitter
a) Accuracy: 0.3 percent of range
b) Fluid Temperature Range: 32 to 100 DegF
4) Suction Pressure Transmitter (when other than submersible pump or vertical turbine (suspended) pump.
a) Accuracy 0.35 percent of range.
b) Fluid Temperature Range: 32 to 100 DegF.
c) For submersible pumps and vertical turbine (suspended) type pumps, suction liquid surface level signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).
5) For pumps, pumping rate (flow) signal from Site's monitoring and control system (e.g., plant PLC/SCADA system)
6) Equipment/motor bearing temperature signal from Site's monitoring and control system (e.g., plant PLC/SCADA system)).
7) Pump/motor vibration signal from Site's monitoring and control system (e.g., plant PLC/SCADA system).

D. Infrared Thermography Testing Program:
1. Testing firm:
a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
a. Minimum of one year field experience covering all phases of field thermography testing and data gathering.
b. Supervisor certified by NETA or NICET.
3. Analysis personnel:
a. Minimum three years combined field testing and data analysis experience.
b. Supervisor certified by NETA or NICET.

E. Electrical Equipment and Connections Testing Program:
1. Qualification requirements as specified in section 26 08 13 - Acceptance Testing.

F. Miscellaneous:
1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:
a. More than one manufacturer is listed for a given "product" in Specifications.

b. No manufacturer is listed.

2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations.

3. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and verify their compatibility.

1.3 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:

1. Located on or suspended from elevated slabs with supported equipment weighing 2000 pounds or greater, or;

2. Located on or suspended from roofs with supported equipment weighing 500 pounds or greater, or;

3. Located on slab-on-grade or earth with supported equipment weighing 5000 pounds or more.

C. Equipment:

1. One or more assemblies capable of performing a complete function.

2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.

3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

E. Baseplate or equipment base plate or machine base

1. Are fabricated frames of structural shapes and plates with enough strength and sturdiness to serve as the surface to which other equipment is attached to and supported by. Baseplates can be directly mounted and grouted to concrete equipment support bases or machined and bolted to a sole plate.

F. Sole plate

1. A thick steel machined plate that is attached to and grouted to a concrete equipment support base.

2. Base plates are bolted to a sole plate when a sole plate is specified and/or provide.

1.4 SUBMITTALS

A. Shop Drawings:

1. General for all equipment:

a. Data sheets that include manufacturer's name and complete product model number.

1) Clearly identify all optional accessories that are included.

b. Acknowledgement that products submitted comply with the requirements of the standards referenced.

c. Manufacturer's delivery, storage, handling, and installation instructions.
d. Equipment identification utilizing numbering system and name utilized in Drawings.
e. Equipment installation details:
    1) Location of anchorage.
    2) Anchorage setting templates.
    3) Manufacturer's installation instructions.
f. Equipment area classification rating.
g. Shipping and operating weight.
h. Equipment physical characteristics:
    1) Dimensions (both horizontal and vertical).
    2) Materials of construction and construction details.
i. Equipment factory primer and paint data.
j. Manufacturer's recommended spare parts list.
k. Equipment lining and coatings.
l. Equipment utility requirements include air, natural gas, electricity, and water.
m. Ladders and platforms provided with equipment:
    1) Certification that all components comply fully with OSHA requirements.
    2) Full details of construction/fabrication.
    3) Scaled plan and sections showing relationship to equipment.

2. Mechanical and process equipment:
    a. Operating characteristics:
        1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
        2) Brake horsepower requirements.
        3) Copies of equipment data plates.
    b. Piping and duct connection size, type and location.
    c. Equipment bearing life certification.
    d. Equipment foundation data:
        1) Equipment center of gravity.
        2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
        3) Type, size, and materials of construction of anchorage.
        4) Data required by Section 03 15 19 Anchorage to Concrete for anchor rod design.
3. Electric motor:
    a. Motor manufacturer and model number.
    b. Complete motor nameplate data.
    c. Weight.
    d. NEMA design type.
    e. Enclosure type.
    f. Frame size.
    g. Winding insulation class and temperature rise.
    h. Starts per hour.

i. Performance data:
   1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage a minimum permissible or specified terminal voltage for all main pump motors.
   2) Time-current plots with acceleration versus current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all main pump motors.
   3) Guaranteed minimum efficiencies at 100 percent, 75 percent, and 50 percent of full load.
   4) Guaranteed minimum power factor at 100 percent, 75 percent, and 50 percent of full load.
   5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
   6) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
j. Bearing data and lubrication system.
k. Natural frequency calculations for:
   1) Completed assembly including but not limited to the equipment base, rotating piece of equipment, and the rotating piece of equipment driver.
   2) Individual piece of rotating equipment.
   3) Equipment driver and connected gear reducer, if applicable.
l. Thermal protection system including recommended alarm and trip settings for winding and bearing RTD's.
m. Fabrication and/or layout drawings:
   1) Dimensioned outlined drawing.
   2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).
n. Certifications:
   1) When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
   2) When utilized with a variable frequency controller, certify motor is inverter duty and the controller and motor are compatible.
      a) Include minimum speed at which the motor may be operated for the driven machinery.
o. Electrical gear:
   1) Unless specified in a narrow-scope Specification Section, provide the following:
      a) Equipment ratings: Voltage, continuous current, kVa, watts, short circuit with stand, etc., as applicable.
   2) Control panels:
      a) Panel construction.
      b) Point-to-point ladder diagrams.
      c) Scaled panel face and subpanel layout.
      d) Technical product data on panel components.
      e) Panel and subpanel dimensions and weights.
      f) Panel access openings.

g) Nameplate schedule.
h) Panel anchorage.
i) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.

4. Systems schematics and data:
   a. Provide system schematics where required in system specifications.
      1) Acknowledge all system components being supplied as part of the system.
      2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
      3) Provide technical data for each system component showing compliance with the Contract Document requirements.
      4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.
5. For factory painted equipment, provide paint submittals in accordance with Section 09 96 00.
6. Qualifications for:
   a. Natural frequency analysis firm and personnel.
   b. Vibration testing firm and personnel.
   c. Infrared thermography testing firm and personnel.
   d. Electrical equipment and connections testing firm and personnel.
7. Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section:
   a. Natural frequency analysis and calculations.
   b. Vibration testing.
   c. Thermography testing.
   d. Electrical equipment and connection testing.

B. Factory Test Reports:
   1. Natural frequency bump test reports where required for rotating equipment.
      a. Minimum characteristics of impact hammer.
         1) Frequency Range 1 kHz.
         2) Range (5v output) 5,000 pounds-force (22,200 N).
         3) Hammer Sensitivity (7pprox.) 1 mV/lbf (0.23 mV/N).
         4) Resonant Frequency 12 kHz
   2. Motor, equipment and final assembled equipment including motor.
      a. Determine natural frequency of assembled motor prior to shipping to equipment manufacturer or job site.
         1) Individual motor fastened to an “infinitely rigid” mass at the same bolt circle as the final assembled equipment.
      b. Determine natural frequency of the pump.
         1) Pump fastened to an “infinitely rigid” mass at the same bolt circle as the final assembled equipment.
      c. Determine natural frequency of the pump/motor assembly.
         1) Pump/motor assembly fastened to an “infinitely rigid” mass at the same bolt circle as the final field assembled equipment.

d. For this use, the "infinitely rigid" mass shall be at least 10 times the weight of the equipment being tested.

3. Submit natural frequency report(s) for approval prior to shipment.
4. Equipment performance tests.
   a. As listed in individual equipment specifications.

C. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:

1. Notification, at least one week in advance, that testing will be conducted at factory.
2. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
3. Submit sample Manufacturer's Field Service Report (MFSR). Report shall use manufacturer’s standard report or use the form in the Exhibits and have at least the following information:
   a. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
   b. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
   c. Motor test reports.
   d. Field noise testing reports if such testing is specified.
   e. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
   f. Provide three bound final written reports documenting natural frequency testing, vibration monitoring and testing for specified equipment.
      1) Include the acceptance criteria of all equipment tested.
      2) Provide individual tabbed sections for information associated with each piece of tested equipment.
   g. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
   h. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
   i. Certification that driven equipment and VFD are compatible.
4. Submit completed Manufacturer's Field Service Report (MFSR) for each piece of equipment supplied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Motors:
    a. ABB Baldor-Reliance.
    b. General Electric.
    c. Hyundai Heavy Industries.
    d. Marathon Electric.
    e. Siemens.
    f. TECO-Westinghouse.
    g. Toshiba U.S.
    h. U.S. Motors, Nidec Motor Corporation.
    i. WEG.
2. Variable frequency drives:
    a. ABB
    b. Eaton
    c. Schneider Electric

2.2 MANUFACTURED UNITS

A. Electric Motors:

1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
2. Design for frequent starting duty equivalent to duty service required by driven equipment.
3. Design for full voltage starting.
4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
5. Size for altitude of Project.
6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.
7. For vertical pump motors provide solid shaft (VSS) unless a hollow shaft (VHS) is specifically required in the narrow scope pump specifications.
8. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
9. AC electric motors less than 1/3 hp:
    a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.
    c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
10. AC electric motors 1/3 to 1 hp:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.
        1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
11. AC electric motors 1-1/2 to 10 hp:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Permanently lubricated sealed bearings conforming to ABMA standards.

c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.

12. AC electric motors greater than 10 hp:
    a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
    b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
        1) Design bearing life for 90 percent survival rating at 50,000 hours of operation for motors up to and including 100 hp.
        2) For motors greater than 100 hp, design bearing life for 90 percent survival rating at 100,000 HRS of operation.
    c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
    d. Thermal protection:
        1) For motors 50 hp and above controlled from a variable frequency drive and for all other motors 100 hp and above, provide one of the following:
            a) Integral thermal detectors (thermostat) per phase with normally closed contacts wired in series that will open on overtemperature
            b) Resistance type temperature detector (RTD) complete with monitor and alarm panel having a normally closed contact that will open on overtemperature.
                (1) Two thermal sensing devices per phase in each phase hot-spot location.
                (2) Monitor and alarm panel:
                (a) For constant speed motors, install panel in and energize from the motor starter equipment.
                (b) For variable speed motors, install panel in and energize from the variable speed drive equipment.
13. Severe duty motor to have the following minimum features:
    a. All cast iron construction.
    b. Gasketed conduit box.
    c. Epoxy finish for corrosion protection.
    d. Hydroscopic varnish on windings for corrosion protection.
    e. Drain plug and breather.

B. NEMA Design Squirrel Cage Induction Motors:
    1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
    2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
    3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
    4. For use on variable frequency type adjustable speed drives, provide:
        a. Induction motors that are in compliance with NEMA MG 1, Part 31.
        b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
        c. Insulated drive end bearing on all motors.
        d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 100 hp and larger.
        e. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 hp and larger.

f. Shaft grounding ring on all motors:
   1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
   2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
g. Have the following minimum turndown ratio without the use of additional cooling, such as a blower, to provide continuous supply of cooling air over the motor.
   1) Variable torque: 10:1.
   2) Constant torque: 6:1.

5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 degrees C ambient.
6. Design motors for continuous duty.
7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 percent greater than the maximum HP requirements of the driven equipment over its entire operating range.
   a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.
8. Motor enclosure and winding insulation application:
   a. The following shall apply unless modified by specific Specification Sections:

MOTOR LOCATION	MOTOR ENCLOSURE / WINDING INSULATION
Unclassified Indoor Areas	, WP-I (for vertical motors),
Wet indoor Areas	[TEFC, Standard Insulation] [TEFC, Encapsulated Windings] [WP-II (for vertical motors)]
Wet outdoor Areas	[TEFC, Extra Dip and Bake for Moisture] [TEFC Encapsulated Windings] [WP-II (for vertical motors)]
Corrosive Areas	TEFC, Severe/ Chemical Duty
Class I, Division 1 Areas	Explosion Proof, Approved for Class I Division 1 Locations
Class II, Division 1 Areas	Explosion Proof, Approved for Class II Division 1 Locations
Class I or Class II, Division 2 Areas	Explosion Proof, Approved for Division 1 Locations or TEFC with maximum external frame temperature compatible with the gas or dust in the area,

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.
10. Balance motors to ISO G2.5 level.
    a. Submit prior to shipping to equipment manufacturer or job site.

C. Variable Frequency Drives: See specification 26 29 23

D. Vibration Isolators:
   1. Provide all equipment subject to vibration with restrained spring type vibration isolators or pads according to the manufacturer's written recommendation.

E. Space Heaters:

1. Silicone rubber strip type, 120 V rated.
2. Provided on:
    a. All motors 10 hp and larger mounted outdoors.
    b. Indoor motors in humid environments as indicated.

2.3 COMPONENTS

A. Gear Drives and Drive Components:

1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
2. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
3. Design drive units for 24 hour continuous service, constructed so oil leakage around shafts is precluded.
4. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.
5. Gear reducers:
    a. Provide gear reducer totally enclosed and oil lubricated.
    b. Utilize antifriction bearings throughout.
    c. Provide worm gear reducers having a service factor of at least 1.20.
    d. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.

2.4 ACCESSORIES

A. Guards:

1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
2. Interior applications:
    a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
    b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 inches spacing.
    c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
3. Exterior applications:
    a. Construct from 16 GA stainless steel or aluminum.
    b. Construct to preclude entrance of rain, snow, or moisture.
    c. Roll to conform to shaft or coupling surface.
    d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:

1. Cast-in-place anchorage:
    a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
    b. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
    c. Provide two nuts for each bolt.
2. Drilled anchorage:
    a. Adhesive anchors per Section 03 15 19.

b. Epoxy grout per Section 03 31 30.

c. Threaded rods same as cast-in-place.

C. Data Plate:

1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.

2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

D. Gages:

1. Provide gages in accordance with Section 40 73 00.

2. Provide at the following locations:

a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.

b. At locations identified on Drawings.

3. Utilize tapping sleeves for mounting per Section 40 05 00.

E. Lifting Eye Bolts or Lugs:

1. Provide on all equipment 50 pounds or greater.

2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

2.5 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.

1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.

1. Provide drain connection for 3/4 inches PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that cannot be properly prepared and painted.

1. When such back to back fabrication cannot be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.

2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Section 07 92 00.

I. Natural frequency/critical Speed:

1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
2. Excessive vibration is sufficient cause for equipment rejection.
3. Ratio of all rotative speeds to natural frequency/critical speed of a unit or components: Greater than 1.2.

J. Equipment Base

1. Adequate grout and vent openings to allow grout to flow under entire base.

K. Control Panels Engineered and Provided with the Equipment by the Manufacturer:

1. Manufacturer's standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.
2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer's standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
3. Affix entire assembly with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to delivery.
   a. Control panels without an affixed UL 508A or UL 698A label shall be rejected.
4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
   a. Determine the SCCR rating by one of the following methods:
      1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
      2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
      3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
   b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
   c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

2.6 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:

1. Provide factory-applied paint coating system(s) for all electrical equipment components except those specified in Section 09 96 00 to receive field painting.
   a. Field painted equipment: See Section 09 96 00 for factory applied primer/field paint compatibility requirements.

B. Field paint other equipment in accordance with Section 09 96 00.

1. See Section 09 96 00 for factory applied primer/field paint compatibility requirements.

2.7 SOURCE QUALITY CONTROL

A. Motor Tests:

1. Test motors in accordance with NEMA and IEEE standards.
2. Provide routine test for all motors.

3. The Owner reserves the right to select and have tested, either routine or complete, any motor included in the project.
    a. The Owner will pay all costs, including shipping and handling, for all motors successfully passing the tests.
    b. Pay all costs, including shipping and handling, for all motors failing the tests.
    c. If two successive motors of the same manufacturer fail testing, the Owner has the right to reject all motors from that manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment as shown on the Drawings and other Contract Documents, in accordance with manufacturer's written instructions, and in accordance with Laws and Regulations. Where the Contract Documents, manufacturer's written instructions, or Laws and Regulations conflict, obtain interpretation or clarification from Engineer before proceeding.

B. Utilize appropriate templates for anchorage placement for equipment installed on concrete.

C. Equipment Drainage Discharges:

1. For equipment having drainage requirements, such as seal water, provide 3/4-inch copper, PVC, or clear plastic tubing from drainage discharge at equipment base to nearest floor drain or equipment drain. Do not discharge liquid across floors.
2. Furnish and install bell up at each equipment base.
3. Route equipment drainage piping clear of major traffic areas, to discharge to locations approved by Engineer. To extent practical, avoid creating tripping hazards.

D. Coordination of Equipment Supports and Bases with Structures:

1. Do not construct foundations until major equipment supports are approved by Engineer.

E. Equipment Lubrication Points:

1. Extend all non-accessible or difficult-to-access lubrication fittings to reasonably accessible locations to facility operation and maintenance personnel without use of ladders or elevating devices, by providing stainless steel tubing (of appropriate wall thickness for the service and application) to a location which allows easy access of fittings from closest operating floor level.

F. Concrete Equipment Support Bases:

1. Install level in both directions, with acceptable vertical tolerance of 1/4-inch±.
2. At anchorage locations, install bases flat and level.

G. Machine Bases / Sole Plates:

1. Existing to remain if sole plate is acceptable to manufacturer.
2. Grease or tape anchorages and jack screws to inhibit grout from adhering to bolts and other anchors.
    a. Jack screws number and size by equipment manufacturer.
        1) Jack screw
            a) 304 Stainless Steel minimum

b) 0.5 inches diameter minimum

2) Jack Screw Pad

a) 2 inch diameter minimum

b) Anchored in place with a structural epoxy adhesive.

3. Install machine base of rotating equipment on equipment base.
4. Level in both directions using jack screws, with a machinist level, according to machined surfaces on base. Base shall be level within vertical tolerance of the lesser of (a) 0.005 inch per foot with no more than 0.0005 inches difference between any two points, or (b) equipment manufacturer's written instructions.
5. Level machine base on equipment base and align couplings between driver and driven equipment.

H. Couplings for Rotating Equipment:

1. Align in annular and parallel positions.
   a. For equipment rotating at 1200 rpm or less, align both annular and parallel within 0.001 inch tolerance for couplings four-inch size and smaller.
   b. Couplings larger than four-inch size: Increase tolerance 0.0005 inch per inch of coupling diameter above four-inch; for example: for six-inch coupling, tolerance is 0.002 inch. For 10 inch coupling, required tolerance is 0.004 inch.
   c. For equipment rotating at speeds greater than 1200 rpm, tolerance for both annular and parallel positions shall be rate of 0.00025 inch (or less) per inch of coupling diameter.
2. If equipment is furnished by manufacturer as mounted unit , verify factory alignment after installation at the Site. Realign if as necessary, in accordance with equipment manufacturers' written instructions, to provide required factory tolerance..
3. Inspect surfaces for runout before attempting to trim or align units.

I. Grouting:

1. Level onto equipment base with jack screws in accordance with the Contract Documents, provide a dam or formwork around base to contain grout between equipment base and equipment support pad.
2. Preparation:
   a. Extend dam or formwork to cover leveling shims and blocks.
   b. Anchor sleeves:
      1) Required for equipment (Pumps, Mixers, Blowers) greater than 50 hp
      2) If anchor sleeves were used, fill voids in anchor sleeves with foam or room temperature vulcanizing (RTV) silicone to keep grout from filling sleeves.
   c. Do not use nuts below the machine base to level the unit.
   d. Saturate top of roughened concrete surface with water before grouting.
3. Grout Installation:
   a. Install grout until entire space under machine base is completely filled to underside of base. Voids are unacceptable.
   b. Puddle grout by working a stiff wire through the grout and vent holes, to ensure grout is installed properly and to release air entrained in grout or base cavity.
4. After Grout Installation:
   a. When grout is sufficiently hardened, remove dam or formwork and finish exposed grout surface to fine, smooth surface.

b. Completely cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too-rapid evaporation of water from grout.

c. Check for voids by tapping along the top deck of the mounting plate. A solid thud indicates grout-filled areas while a drum-like hollow sound indicates a void requiring filling.

1) Void areas are to be filled by drilling 1/8 inches NPT holes in opposite corners of each void area. Grout to be pumped into one void with a grout gun until grout emerges from the other vent hole.

d. When grout is fully hardened (after not less than seven days), remove jack screws, and tighten nuts on anchor bolts and similar anchors to required torque.

e. Inspect and verify levelness of machine base and, if not in accordance with requirements, remedy by removing base and reinstalling in accordance with the Contract Documents.

f. Inspect driver-driven equipment for proper alignment. When not in accordance with requirements, remedy so that the Work is not defective.

3.2 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.

1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report certifying that equipment:

1. Has been properly installed and lubricated.
2. Is in accurate alignment.
3. Is free from any undue stress imposed by connecting piping or anchor bolts.
4. Has been operated under full load conditions and that it operated satisfactorily.

a. Secure and deliver a field written report to Owner immediately prior to leaving jobsite.

C. No separate payment shall be made for installation checks.

1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.3 IDENTIFICATION OF EQUIPMENT AND HAZARD WARNING SIGNS

A. Identify equipment and install hazard warning signs in accordance with Section 10 14 00.

3.4 FIELD PAINTING AND PROTECTIVE COATINGS

A. For required field painting and protective coatings, comply with Section 09 96 00, High Performance Industrial Coatings.

3.5 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape stripped ends of conductors and associated connectors with electrical tape.

1. Wrapping thickness shall be 150 percent of the conductor insulation thickness.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.6 FIELD QUALITY CONTROL

A. General:

1. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
2. Execute pre-demonstration requirements in accordance with Section 01 75 00.
3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
4. Provide testing for all equipment furnished or installed as part of the Work.
5. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptable standards.
6. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
   a. Contract Drawings and Specifications.
   b. Related construction change documentation.
   c. Approved Shop Drawings.
   d. Approved Operation and Maintenance Manuals.
   e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:

1. Approved in accordance with Shop Drawing submittal schedule.
2. Included as a minimum:
   a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
   b. List and description of testing and analysis equipment to be utilized.
   c. List of all equipment to be testing, including:
      1) Name and tag numbers identified in the Contract Documents.
      2) Manufacturer's serial numbers.
      3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:

1. Minimum calibration frequency:
   a. Field analog instruments: Not more than 6 months.
   b. Field digital instruments: Not more than 12 months.
   c. Laboratory instruments: Not more than 12 months.
   d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
2. Carry current calibration status and labels on all testing instruments.
3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:

1. Provide reports with tabbed sections for each piece of equipment tested.
2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
    a. Include legible copies of all forms used to record field test information.
3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment
    a. Include data gathering and sample test report forms that will be utilized.
4. In the final report, include as a minimum, the following information for all equipment tested:
    a. Equipment identification, including:
        1) Name and tag numbers identified in the Contract Documents.
        2) Manufacturer's serial numbers.
        3) Other pertinent manufacturer identification,
    b. Date and time of each test.
    c. Ambient conditions including temperature, humidity, and precipitation.
    d. Visual inspection report.
    e. Description of test and referenced standards, if any, followed while conducting tests.
    f. Results of initial and all retesting.
    g. Acceptance criteria.
    h. "As found" and "as left" conditions.
    i. Corrective action, if required, taken to meet acceptance.
    j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
    k. Instrument calibration dates of all instruments used in testing.
5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:

1. Perform testing on Electrical equipment, connections, and motors in accordance with 26 08 13 - Acceptance Testing.

F. Other Testing:

1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
    a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

G. Infrared Thermography Testing Program:

1. Perform infrared thermography testing for equipment specified in other Divisions during the Equipment Demonstration Period.
    a. Perform on all rotating and reciprocating equipment having drivers 25 hp or greater.
2. Additional requirements for infrared thermography monitoring and testing equipment:

a. Temperature range: -10 to 350 degrees C.
b. Accuracy: ±2 percent or 2 degrees C, whichever is greater.
c. Repeatability: ±1 percent or 1 degree C, whichever is greater.
d. Temperature indication resolution: 0.1 degrees C.
e. Minimum focus distance: 0.3 meters.
f. Output in color palettes: JPEG, BMP, or other digital format compatible with Windows.

3. Perform inspection per ASTM E1934.
   a. Operate VFD driven equipment at 100 percent speed during thermographic inspection.
4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 degrees C per ASTM E1934.
5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DEGC above the equipment and/or bearing manufacturers published criteria.

H. Equipment Field Vibration Monitoring and Testing Program:

1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
2. Perform field vibration testing on each item of rotating and reciprocating equipment having driver 50 HP and greater
3. Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G6.3 criteria.
4. Acceptability of pumping equipment to be based on current ANSI/HI criteria:
   a. ANSI/HI 11.6-2012 for Submersible Pumps in a Wet-pit or Dry-pit configuration.
   b. ANSI/HI 9.6.4-2016 for all other centrifugal pumps.
5. Utilize an Engineer approved 3rd party testing agency to perform vibration monitoring and testing on equipment.
6. For variable speed equipment provide vibration testing at no more than 3 percent increments of maximum speed throughout entire operating range.
7. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency.
8. Tolerances for pumping equipment shall be per HI published standards.
9. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
10. Document testing with written report.
    a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.
    b. Natural frequency of installed equipment utilizing an impact hammer.
    c. Report to include graphical plots of vibration signature for each test point at a scale which illustrates all vibration levels greater than 0.025 ips RMS.

I. Equipment Vibration Testing Schedule:

EQUIPMENT NAME	TAG NO.	SPECIFICATION REFERENCE

3.7 DEMONSTRATION

A. Demonstrate equipment in accordance with Section 01 75 00.

3.8 ABBREVIATION TABLE

A. As indicated on the Drawings.

END OF SECTION

EXHIBIT A

MANUFACTURER FIELD SERVICE REPORT

This field service report is generic in nature. An electronic copy of this form will be furnished upon request from the Engineer. This report is to reflect that all requirements of the Operations and Maintenance Manual and the individual equipment specification requirements have been performed for the installation and operation and also to provide a baseline for amperage draw for each phase, vibration readings, rotation, alignment and all other applicable tests required to insure that the equipment has been installed properly. A MFSR will be required for each individual piece of equipment requiring a MFSR.

Definitions of Reports:

Initial service report: Required for construction preparations. Equipment delivered to site is in good condition and conforms to specification requirements. Anchor bolts, hardware and ancillary items (piping, flanges, conduits, fuel/power supply) are compatible with equipment.

Interim service report: Required for equipment installation onto base or foundation. Piping connections, electrical and control connections or structural attachment are complete. For equipment stored on site over four weeks, interim service report will document that manufacturer's long-term storage procedures have been incorporated and equipment has not been damaged, nor coatings deteriorated.

Final service report is to be completed when equipment can be started, electrical amperage and voltage draw measured, cold and hot alignments performed, vibration testing and monitoring performed and the equipment is found to be in compliance with Manufacturer's operating parameters and the requirements of the individual equipment specifications.

PROJECT: _____

Report Status:

Initial Service Report completed and submitted on _____

Interim Service Report completed and submitted on _____

Final Service Report completed and submitted on _____

Commencement of Warranty _____

I Description

A. Equipment Name and Identification: _____

_____

B. Serial Number: _____

C. Specification Section Number: _____

D. Manufacturer: _____

E. Representative: _____

F. Type of Service: Initial _____Interim _____Final _____

II General Review

A. The above referenced equipment/material/supplies have been inspected, checked, and adjusted. Yes _____ No _____

Summary: _____

_____

B. The above referenced equipment/material/supplies were placed upon properly prepared or suitable substrate. N/A _____Yes _____No _____

Summary: _____

_____

C. The above referenced equipment/material/supplies are free from any undue stress imposed by any connected piping, anchor bolts or any other load. N/A _____Yes _____No _____

Summary: _____

_____

D. The above referenced equipment/material/supplies have operated under design conditions. N/A _____Yes _____No _____

Summary: _____

_____

E. The above referenced equipment/material/supplies have been installed in accordance with the manufacturer's recommendations and the Procurement Documents, require no corrective work, and are hereby approved. Yes _____No _____

Summary: _____

_____

F. The above referenced equipment/material/supplies are acceptable to the manufacturer as installed providing the following corrective action(s) are performed:

1. _____
2. _____
3. _____
4. _____
5. _____

III Inspection Checklist

Item	Acceptable (Yes/No)	Readings/Comments
Bearings (1)		
Belts (tension reading)		
Lubrication Levels		
Vibration (1) (2) (MILS/SEC)		
Infrared Thermography (1) (2)		
Starting AMPS		
Full Load AMPS		
Volts		
Rotation		
Jacket Temperature (DEGF)		
Seal Water Flow Rate (GPH or GPM)		
Seal Water Pressure (PSI)		
O-rings/Packing		
Alignment (1)		
Anchor Bolts		
Anchor Bolt Torque		
Grout		
Substrate Approval		
Sound level (4 feet from unit) (1) (dB)		
Other		

Item	Acceptable (Yes/No)	Readings/Comments

(1) Inspection or testing reports must be attached.
(2) Provide vibration testing and monitoring procedures for Engineer's review and approval prior to testing.

IV O&M Manuals

A. The O&M manual as presented contains all information required for proper operation, maintenance, and instruction of this system. N/A _____Yes [_____] No [_____]

Summary: _____

_____

V Preventive Maintenance

A. The preventive maintenance summary outlined in the O&M manual is acceptable for operation of the system throughout the warranty period. N/A _____Yes _____No _____

Summary: _____

_____

VI Operator Training/Classroom Instruction

A. Training and instruction have been performed in accordance with the requirements of the Procurement Documents. N/A _____Yes _____No _____

B. Final Training/Classroom Instruction Completed on: _____

Summary: _____

_____

VII Remarks

_____

_____

_____

VIII Certification

I hereby certify, that I, _____, am a duly authorized representative of the manufacturer, that I am empowered by the manufacturer to inspect, approve, and operate his equipment, and that I am authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as modified herein. I also certify that all information contained herein is true and accurate.

By: _____
(Authorized Representative)

For: _____

Date: _____

IX Acknowledgments

By: _____

For: _____
(Contractor)

Date: _____

By: _____

For: _____
(Engineer)

Date: _____

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SECTION 01 62 00
PRODUCT OPTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contractor's options for selecting materials and equipment.
2. Requirements for consideration of "or equal" materials and equipment.

1.2 CONTRACTOR'S PRODUCT OPTIONS

A. For materials and equipment specified only by reference standard or description, without reference to Supplier, furnish materials and equipment complying with such reference standard and descriptive requirements in the Contract Documents, by a Supplier or from a source that complies with the Contract Documents.

B. For materials and equipment specified by naming one or more items or Suppliers, furnish the named materials and equipment that comply with the Contract Documents, unless an "or equal" or substitute item is approved by Engineer.

C. For materials and equipment specified by naming one or more items or Suppliers and the term, "or equal", when Contractor proposes a material or equipment item or Supplier as an "or equal", submit to Engineer a request for approval of an "or equal" item or Supplier.

D. For materials and equipment specified by naming only one item or manufacturer and followed by words indicating that no substitution or "or equal" is allowed, there is no option and no "or equals" or substitutes will be allowed or approved.

1.3 "OR EQUAL" ITEMS

A. Procedure: The following augments the requirements of the General Conditions, as may be modified by the Supplementary Conditions:

1. For proposed materials and equipment, whether or not indicated by name in the Contract Documents, and considered by Contractor as an "or equal" in accordance with the General Conditions, Contractor shall request in writing Engineer's approval of each proposed "or equal".
2. Request for approval of an "or equal" item shall accompany the Shop Drawing, product data Submittal, or Sample for the proposed item. Engineer may reject or otherwise not approve or accept any such request or Submittal that is incomplete.
3. Indicate on the Schedule of Submittals which Submittals were for proposed "or equals" and which were approved as "or equals".
4. Clearly indicate in the associated Submittal transmittal whether the Submittal includes request for approval of a proposed "or equal".
5. Comply with the Contract Documents' requirements to clearly indicate all proposed deviations from the requirements of the Contract Documents. Where the Contract Documents do not otherwise require such indication, Contractor shall indicate in detail, both in the Submittal for the "or equal" item and in separate, written correspondence, each proposed deviation from the requirements of the Contract Documents.
6. Requirements for furnishing information and documents related to proposed "or equals" shall be furnished with the initial Submittal for that item and for all subsequent re-Submittals, if any.
7. Engineer's approval, if any, of a proposed "or equal" will be indicated by the Engineer's approval of the associated Shop Drawing, product data Submittal, or Sample, as applicable, unless otherwise indicated on the associated Submittal.

8. Should Engineer reject or otherwise not approve a proposed “or equal”, Contractor may propose the item as a substitute, subject to the Contract Documents’ requirements concerning requests for approval of substitute items or procedures.

B. Contractor’s request for approval of each proposed “or equal” shall include:

1. Contractor’s written request that the proposed item be considered as an “or equal” in accordance with the General Conditions and this Specifications section.
2. Contractor’s certifications required in the General Conditions.
3. Documentation adequate to demonstrate to Engineer that proposed item does not require extensive revisions to the Contract Documents, that proposed item is consistent with the Contract Documents, and that proposed item will produce results and performance required in the Contract Documents, and that proposed item is compatible with other portions of the Work.
4. Detailed comparison of significant qualities of proposed item with the materials and equipment and Suppliers named in the Contract Documents. Significant qualities include attributes such as performance, weight, size, durability, corrosion resistance in the service environment, visual and textural effect and attributes, and specific features and requirements shown or indicated.
5. Evidence that proposed item’s manufacturer will furnish warranty equal to or better than that specified, if any.
6. List of similar installations for completed projects with project names and addresses, and names, address, telephone number, and e-mail address of design professionals and owners, when requested by Engineer.
7. Samples, when requested by Engineer.
8. Other information requested by Engineer.

C. When used in the Contract Documents, the terms “or equal”, “or-equal”, and “or approved equal” have the same meaning and refer to materials or equipment proposed by Contractor for Engineer’s approval as equivalent to materials or equipment indicated in the Contract Documents using the name of specific manufacturers or products. Such materials or equipment shall be incorporated into the Work only after being duly approved in writing by Engineer.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 64 00
OWNER-FURNISHED PRODUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements and procedures for Owner-furnished materials and equipment to be installed by Contractor, including:
   a. Handling and storage of Owner-furnished items.

B. Scope:

1. Contractor shall provide labor, materials, tools, equipment, services, and incidentals shown, specified, and necessary for accepting, handling, insuring, storing, and maintaining as required, installing, checking out, starting-up, and completing Owner-furnished materials and equipment in accordance with the Contract Documents.

1.2 OWNER FURNISHED MATERIALS AND EQUIPMENT

A. Items of equipment and materials are furnished by Owner for installation by Contractor are indicated below.

1. Furnished under procurement contract separately entered into by Owner (as “buyer”) with a Seller:
   a. Step-down Transformer (Transformer)
2. Transformer was delivered to project site in Spring 2026. Transformer is located within the existing fenced substation adjacent to the pumping plant and near the proposed Transformer Vault location.
   a. Vault Completion:
      1) The contractor shall construct the Transformer Vault and relocate and place the transformer on the vault by the date provided within Milestone 1A defined in Section 01 14 16 – Coordination with Owner’s Operations.
      2) Once the Transformer Vault is completed, Contractor shall provide the equipment and resources to relocate the Transformer from the substation area to the Vault. The transformer and oil tank weighs approximately 12,000 pounds without oil.
      3) Upon completion of the Vault and placement of the Transformer, <u>the Contractor shall protect the Vault foundation from surface water intrusion</u> until such time the foundation drain system is installed and functional.
   b. The Contractor shall notify the Owner regarding the status of the relocation of the Transformer to the Transformer Vault and provide completion date two weeks in advance. The Owner will notify Seller of the date and indicate Transformer’s readiness for field testing.
   c. Contractor shall notify Owner, Engineer and Idaho Power Company thirty (30) days in advance of the requirement for connecting the transformer to the new 12.5kV power service. The action of connecting the transformer to the new 12.5kV power service will occur after Milestone 1 and no earlier than shut down of the pump station for the 2028 irrigation season.

B. Availability of Owner-Furnished Materials and Equipment:

1. Owner-furnished materials and equipment have been delivered to the project site.

C. For Owner-furnished materials and equipment obtained via procurement contract, Engineer will keep Contractor informed of probable delivery dates, if applicable, of the materials and equipment included in the procurement contract.

D. Owner’s Responsibilities:

1. Within 10 days after the Effective Date of the Contract, Owner will arrange for and deliver to Contractor an electronic copy (in portable document format; PDF) of seller's shop drawings), and other submittals as reviewed by Engineer or Owner. Such submittals, whether approved or otherwise, are not part of the Contract Documents.
2. The Owner shall pay for services of seller's factory-trained representative to furnish consultation and advice during installation of associated Owner-furnished materials and equipment, to inspect, check, and approve installation before operation, and to furnish technical advice and direction during start-up and field quality control activities for Owner-furnished materials and equipment. Extent to which services of seller's representative will be provided during installation will be in accordance with the procurement contract documents.
3. If services of seller's representative beyond the scope of such services set forth in the procurement contract document is desired by Contractor, or if such services are necessary as a result of defective Work by Contractor, Contractor shall arrange and pay for such services of seller's representative.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review installation procedures for Owner-furnished materials and equipment and coordinate installation of items to be installed with or before Owner-furnished materials and equipment.

B. Scheduling:

1. Comply with the Contract Time indicated in the Contract Documents, and Section 01 14 16 - Coordination with Owner's Operations.

1.4 HANDLING AND STORAGE

A. Handling:

1. Handle Owner-furnished materials and equipment in accordance with the Contract Documents and manufacturer's written instructions. Handle so that warranties in effect are not voided.

B. Storage:

1. Maintain Owner-furnished materials and equipment storage in accordance with the manufacturer's storage requirements. Upon relocation of the Transformer to the Transformer Vault, store in accordance with manufacture's written instructions so that warranties in effect are not voided.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 71 14
MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Construction mobilization and demobilization.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals to perform mobilization and demobilization for the Work.
2. This Section is general and does not necessarily indicate all activities required for mobilization and demobilization, which may be indicated in other parts of the Contract Documents.,

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 14 16 - Coordination with Owner's Operations.
2. Section 01 22 00 - Measurement and Payment.
3. Section 01 29 73 - Schedule of Values.
4. Section 01 57 20 – Environmental Protection
5. Section 01 57 90 – Preservation of Archeological Data
6. Section 01 57 05 - Temporary Controls.
7. Section 01 74 00 - Cleaning.

1.02 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:

1. Where costs of mobilization and demobilization are to be included in a specific bid/pay item, such item is indicated in the Contract, including Section 01 22 00 - Measurement and Payment.
2. Where the Contract does not expressly require costs for mobilization and demobilization are to be under specific bid/pay item(s), Contractor may allocate such costs among bid/pay items as Contractor deems appropriate.
3. Where mobilization and demobilization is to be part of a larger lump sum bid/pay item, limitations on eligibility for payment of mobilization and demobilization costs are indicated in Section 01 29 73 - Schedule of Values.

B. If costs for mobilization, demobilization, or both change as a result of Contract modifications, include the total cost of such changes to mobilization and demobilization in Change Proposal submitted for each associated change. Make no subsequent claim, whether via Change Proposal, Claim, or dispute, for additional compensation for mobilization, demobilization, or both.

1.03 MOBILIZATION AND DEMOBILIZATION - GENERAL

A. Do not commence mobilization at the Site or other areas until:

1. The Contract is signed by both parties and is effective.
2. Required insurance documentation, performance bond, and payment bond have been submitted by Contractor and accepted by Owner, and builder's risk insurance complying with the Contract Documents is furnished and in place, and documentation thereof accepted by the parties.
3. Conditions, if any, of Owner-issued Notice to Proceed, if any, have been complied with by the applicable party.

4. Preconstruction conference(s), including items on agenda for site mobilization matters, is completed.
5. Preconstruction photographic documentation is obtained and submitted in accordance with the Contract Documents.

B. Mobilization Work includes, but is not limited to:

1. Establishing temporary controls in accordance with Section 01 57 05 - Temporary Controls.
2. Establishing Contractor's staging and laydown areas, in accordance with Section 01 14 16 - Coordination with Owner's Operations.
3. Establishing temporary utilities and temporary facilities in accordance with the Contract Documents.
4. Establishing required and necessary temporary project signage.
5. Other mobilization Work required by the Contract Documents, including Section 01 22 00 - Measurement and Payment, and Section 01 29 73 - Schedule of Values.

C. Demobilization Work includes, but is not limited to:

1. Removing from the Site and other areas Contractor's temporary utilities, temporary facilities, temporary signage, temporary security measures; construction equipment, machinery, and tools; ,unused items of materials and equipment; and other items.
2. Final restoration and repair of damage caused by Contractor..
3. Final cleaning in accordance with Section 01 74 00 - Cleaning.
4. Other demobilization Work required by the Contract Documents, including Section 01 22 00 - Measurement and Payment, and Section 01 29 73 - Schedule of Values.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 71 33
PROTECTION OF THE WORK AND PROPERTY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for protecting the Work and property, including:
   a. Site Surveillance and Video Monitoring
   b. Accessing or entering property.
   c. Temporary barricades and temporary warning lights and signs.
   d. Responsibility to remedy damaged property.
   e. Protecting natural habitats, including trees, plants, lawns and meadows, and wildlife.
   f. Protecting Underground Facilities.
   g. Protecting existing surface structures.
   h. Protecting floors, walls, and roofs.
   i. Protecting other installed items and landscaping.

B. Scope:

1. This Section augments requirements of the General Conditions as may be modified by the Supplementary Conditions regarding protection of the Work and property, including Underground Facilities.
2. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required for protecting the Work and property in accordance with the Contract Documents.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 57 05 - Temporary Controls.
2. Section 01 74 00 - Cleaning.

1.2 PROTECTION - GENERAL

A. Contractor shall provide all precautions and programs and perform all actions necessary to protect personnel health and safety, and to protect the Work and all public and private property and facilities from damage, in accordance with the Contract Documents, Laws and Regulations, and other applicable requirements.

B. To prevent damage, injury, and loss, Contractor's actions shall include the following:

1. Providing measures for safety of all personnel at and adjacent to the Site, whether engaged in performing the Work, operating or maintaining the facility, or performing other functions for Owner or others.
2. Storing construction equipment, machinery, tools, and similar items, materials and equipment to be incorporated into the Work, supplies, and other items in an orderly, safe manner that does not unduly interfere with progress of the Work or work of others, including Owner and facility manager (if other than Owner).
3. Suitably storing materials and equipment to be incorporated into the Work, in accordance with the Contract Documents, including Section 01 66 00 - Product Storage and Handling Requirements.
4. Placing upon the Work or any part thereof only loads consistent with the safety and integrity of that portion of the Work and existing construction and facilities.
5. Frequently removing and disposing of rubbish, scrap materials, and debris, in accordance with the Contract Documents, including Section 01 74 00 - Cleaning, resulting from Contractor's operations.

6. Providing temporary controls, including controlling pests and rodents, in accordance with the Contract Documents, including Section 01 57 05 - Temporary Controls.

PART 2 - PRODUCTS

2.1 TEMPORARY BARRICADES

A. Materials and Construction - General:

1. Temporary barricades shall be of materials that are either new or of good quality and sufficient for the intended purpose, exposure, and duration of use.
2. Provide temporary barricades of sturdy materials of grade, thickness, and durability sufficient for the probable loads to which they will be subject. Temporary barricades intended for fall prevention, such as railings and handrails on temporary stairs and temporary walkways and at openings, shall be in accordance with Laws and Regulations, including the applicable building and safety codes.
3. Color: Use appropriately colored and reflective barricades, or paint barricades accordingly, to be visible at night and during periods of low visibility.
4. Where owner of transportation right-of-way or transportation facility having jurisdiction or other authority having jurisdiction requires compliance with standards more stringent than the Contract Documents, comply with both the Contract Documents and requirements of the authorities having jurisdiction.

B. Temporary Snow Fence-type Barriers:

1. Unless shown or indicated otherwise, temporary barrier shall be not less than snow fence-type, four feet high, orange-colored or other high-visibility color. Polyethylene material or other, similar, durable material. Mesh size 1.25-inch by 1.5-inch.
2. Supports: Adequately support barriers to protect persons and property. Vertical supports may be timber, metal, or other appropriate material sufficient for the intended use, exposure, and duration of use. Properly secure fencing to supports with appropriate, stout, wire or other fastenings, sufficient to engage fencing for the intended use.

2.2 SITE SURVEILLANCE AND VIDEO MONITORING

A. Contractor shall install temporary external site cameras capable of providing a live video and audio (2-way) feed over the world wide web to remotely track project progress. Cameras shall be installed prior to the commencement of site work and shall be removed within 48 hours of contract completion. The cameras shall meet the following minimum standards:

1. Camera system shall have a power backup (solar or battery) capability to ensure continuous 24/7 operational viewing.
2. Cameras shall use cellular signals to establish communication between the cameras, security system panels, and live monitoring stations as required.
3. Cameras shall be durable enough to handle diverse environments and climates with limited downtime. Contractor has 24 hours to repair or replace inoperable equipment.
4. Cameras shall record in high definition (1080p) and have the Pan Tilt Zoom (PTZ) option that is capable of remote adjustment and be capable of viewing the exterior of the site.
5. Cameras shall be mounted outside at a minimum of 20 feet above ground level to prevent camera line of site blockage and allow continuous site viewing. A speaker and microphone shall be installed at ground level to allow 2-way communication.
6. Cameras live video and audio feed shall be available 24/7 with active sharable site weblinks and a Mobile Application. Video footage shall be recorded for 30 days and be displayed with date and time counter.
7. Time lapse videos of the construction may be requested by the Contracting Officer depending on the situation.
8. Notification signs will be placed at the site to inform individuals that they are under surveillance.

9. Camera system shall be compliant with Section 889(a)(1)(B) of the John S. McCain National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2019 (Pub. L. 115- 232). For further information see FAR 52.204-24, Representation Regarding Certain Telecommunications and Video Surveillance Services or Equipment in Section K of this solicitation.

PART 3 - EXECUTION

3.1 ACCESSING OR ENTERING PROPERTY

A. Accessing or Entering Property - General:

1. Use and occupy only lands and easements furnished by Owner, unless appropriate consent from property owner and occupants is obtained by Contractor.
2. The foregoing applies to personnel, construction equipment and machinery, tools, vehicles, materials or equipment to be incorporated into the Work, supplies, temporary facilities, and other items or obstructions.

3.2 BARRICADES

A. Temporary Barricades and Temporary Warning Lights and Signs - General:

1. All Work Areas:
   a. Provide temporary barricades, warning lights, and warning signs for both indoor and outdoor Work, in accordance with Laws and Regulations and requirements of owners of affected property and facilities.
   b. Warning Lights and Signage: From 30 minutes before terrestrial sunset to 30 minutes after terrestrial sunrise, provide and maintain not less than one temporary flashing light at each vehicle barricade and at other barriers and barricades as necessary.
   c. Provide temporary barriers where shown or indicated, and where necessary to protect persons and property. At minimum, provide temporary barriers for all excavations that remain open during non-working hours.
   d. Promptly replace temporary barricades that are damaged or are otherwise no longer capable of serving their intended function.
2. Where the Work is performed on or adjacent to roadway, access road, other area travelled by motor vehicles, railroad, or similar transportation right-of-way, or public place:
   a. Provide temporary barricades, temporary fences, temporary guard rails, temporary lights and warning signs, temporary danger signals, and other precautions for protecting persons, property, vehicles, and the Work.
   b. Provide sufficient temporary barricades to keep vehicles from being driven on or into excavations and the Work under construction.
   c. Comply with Section 01 55 26 - Traffic Control.
3. Temporary Barriers for Areas Not Subject to Vehicular Traffic:
   a. Provide temporary barriers around:
      1) Openings.
      2) Scaffolding.
      3) Temporary stairs and ramps.
      4) Around excavations.
      5) Around elevated walkways, slabs, and platforms.
      6) Other areas that may present a fall-hazard or hazard to persons and property.
   b. Provide appropriate temporary barriers, warning signs and, where necessary, warning lights, at ground level and other low elevations, and at higher elevations. Protect persons and property from fall-hazards and protect persons and property at lower elevations from falling objects.
4. Duration of Temporary Barriers, Barricades, Signs, and Warning Lights:

a. Contractor's responsibility for maintaining temporary barriers, barricades, signs, and warning lights shall continue until the associated Work is substantially complete in accordance with the Contract Documents, unless other provision for protection are agreed to by the parties.

b. After Substantial Completion, protect Work and property during periods when Contractor is onsite: completing the remaining Work, performing correction period work, and performing warranty work.

B. Temporary Snow Fence-type Barriers:

1. Establish temporary barriers around excavations and other areas as necessary for the protection of persons and property.
2. Install snow fence-type barriers vertical for entire height of barrier.
3. Maintenance:
   a. Maintain temporary snow fence-type barriers as necessary.
   b. Repair or replace when damaged, when barrier (or any section thereof) is no longer vertical, or when barrier (or any section thereof) is no longer properly supported for its full height and .
   c. Reinstall barriers promptly following temporary removals for performing work and where barrier installation has degraded over original temporary barrier installation.
4. Removal:
   a. Remove temporary barriers from the Site when associated excavation is properly filled and the area is sufficiently safe for persons and other property.

3.3 RESPONSIBILITY TO REMEDY DAMAGED PROPERTY

A. Contractor to Remedy Damage:

1. Contractor has full responsibility for preserving public and private property and facilities on and adjacent to the Site.
2. Direct or indirect damage done by, or on account of, any act, omission, neglect (including inadvertent acts), or misconduct by Contractor (including any person or entity for whom contractor is responsible) in performing the Work, shall be promptly remedied by Contractor, at Contractor's expense, in accordance with the Contract Documents.
3. If the Contract Documents do not show or indicate the required restoration, or remedy, restore or remedy the damage to condition equal or better than that existing before damage was done.

B. Owner May Remedy:

1. Should Contractor fail to protect and safeguard property and the Work after requests from Engineer or Owner, Owner reserves the right to implement measures to protect property and the Work.
2. Cost of such Owner-implemented measures shall be paid by Contractor. Owner may deduct from payments due Contractor such amounts as set-offs in accordance with the Contract Documents.
3. Such right, however, does not obligate Owner or Engineer to continuously monitor or have responsibility for protection of property and the Work, which responsibility is exclusively Contractor's.
4. In exercising its rights under this provision, Owner will endeavor to give Contractor sufficient notice to allow Contractor to remedy the damage or defect within a reasonable time. However, if Owner or Engineer deems that the situation requires prompt remedy, Owner may act as quickly as Owner deems appropriate, without infringing on or mitigating Owner's rights under this provision and elsewhere in the Contract Documents

3.4 PROTECTION OF NATURAL HABITATS

A. Tree and Plant Protection – General:

1. Protect existing trees, shrubs, and plants on or adjacent to the Site, against unnecessary cutting, breaking, damage, and skinning of trunk, branches, bark, and roots.
2. Protect irrigation servicing existing trees, shrubs, and plants on or adjacent to the Site that remain in place.
3. Do not store materials or equipment or park construction equipment, machinery, or vehicles within foliage drip lines.
4. In areas subject to traffic, provide temporary fencing or temporary barricades to protect trees and plants.
5. Burning is not allowed at or adjacent to the Site, including burning, in open fires or otherwise, trees, plants, debris, or other combustible materials.
6. Within the limits of the Work, water trees and plants that are to remain, to maintain their health during construction operations.
7. Cover exposed roots with burlap, and keep such burlap continuously wet. Cover exposed roots with earth as soon as possible. Protect root systems from mechanical damage and damage by storm water runoff, erosion, flooding, and noxious materials in solution.

B. Coordinate the Work in this Article with the following Specifications:

1. Section 31 10 00 - Site Clearing.

C. Remedy of Damaged Trees:

1. If branches are damaged, prune branches immediately and protect as indicated below.
2. If bark on trunk or major branches is scraped or damaged, using a sharp knife or other suitable cutting implement, clean the edge of the wound, leaving the bark smooth and tight against the wood. Avoid exposing more live tissue and do not remove too much healthy bark. Apply material indicated below.
3. After pruning and cutting back damaged wood and bark, protect cut or damaged wood by applying emulsified asphaltic sealant specifically manufactured for sealing pruned and damaged trees. Apply sealant in accordance with sealant manufacturer's instructions, in manner acceptable to Engineer and tree owner.
4. When directed by Engineer, remove and dispose of (at location away from the Site) damaged trees and plants (and parts thereof) that die or suffer permanent injury, and replace each such damaged tree and plant with new tree or plant of equal or better species and quality.

D. Protection of Lawns and Meadows:

1. Protect lawns and meadows from unnecessary damage during performance of the Work.
2. To extent practicable, do not drive vehicles, construction equipment, machinery, or wheeled items such as carts and wheelbarrows, across lawns and meadows.
3. When existing lawn or meadow areas are disturbed, promptly stabilize exposed soil in accordance with Section 01 57 05 - Temporary Controls.
4. Remedy damaged lawns and meadows in accordance with the Contract Documents. If not otherwise addressed in the Contract Documents, restore to preconstruction condition or better with the same or substantively similar species.

E. Protection of Wildlife:

1. To extent practicable, avoid harming wildlife and damaging or destroying wildlife habitats, except for areas where the Work is to be located.
2. In the event a threatened or endangered species is discovered at the Site for which provisions was not otherwise provided, stop work in the vicinity and immediately orally advise Engineer by telephone or in-person, promptly followed by written notice in accordance with the Contract's provisions for notice for differing Site conditions. If species

is not threatened or endangered, promptly resume work; no change in Contract Price or Contract Times is due for misidentification of threatened or endangered species.

3. Contractor is not responsible for wholesale inventorying or Site-wide evaluation of wildlife at the Site, except as indicated in the paragraph immediately above this paragraph.

3.5 PROTECTION OF UNDERGROUND FACILITIES

A. Underground Facilities – General:

1. Underground Facilities known to Owner and Engineer, except laterals or services to individual structures or properties, such as water, wastewater, storm water, gas and fuel, hydronic, steam, electric, and communications laterals or services, are shown on the Drawings. Information shown for Underground Facilities is the best available to Engineer but, in accordance with the General Conditions, as may be modified by the Supplementary Conditions, is not guaranteed to be correct or complete.
2. Comply with Laws and Regulations regarding notification of utility owners prior to performing the Work, including necessary “call before you dig” notifications.
3. Contractor shall explore ahead of trenching and excavating Work and shall sufficiently uncover Underground Facilities that will or may interfere with the Work to determine their location, to prevent damage to Underground Facilities, and to prevent service interruption to structures and properties served by Underground Facilities.
4. If Contractor damages an Underground Facility, Contractor shall promptly restore the damaged Underground Facility in accordance with requirements of the owner of the damaged facility and the Contract Documents. If the Contract Documents do not address repair or remedy of the damaged facility, restore to not less than preconstruction condition.
5. Necessary changes in the location of the Work may be directed by Engineer to avoid Underground Facilities not shown or indicated on the Contract Documents.
6. If permanent relocation of an existing Underground Facility is required and is not otherwise shown or indicated in the Contract Documents, Contractor may be directed in writing to perform the required work. When such relocation Work results in a change in the Contract Price, Contract Times, or both, the associated Contract modification procedures and payment for such Work shall be in accordance with the Contract Documents.

B. Protection of Underground Facilities under Roads and Parking Areas:

1. Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes, valve boxes, vaults, and other Underground Facilities near to, or visible at, the ground surface.
2. Avoid imparting heavy loads, especially transitory loading (such as heavy truck traffic), vibration forces, and impact loads on Underground Facilities that are close to the ground surface and below-grade work areas. Provide temporary bridging or other appropriate protection where traffic must pass over Underground Facilities in close proximity to the ground surface.

C. Temporary Support of Underground Facilities:

1. Where Contractor exposes or excavates around or under one or more existing Underground Facilities, provide appropriate and adequate temporary supports for the associated Underground Facilities.
2. Do not allow Underground Facilities exposed by Contractor’s operations to remain exposed without temporary support necessary to properly protect the Underground Facility. Where joint of Underground Facility is exposed by excavation, provide temporary support for each exposed joint and other temporary support as necessary.
3. Design of Temporary Supports:
   a. Where necessary or where expressly required by the Contract Documents, retain services of professional engineer, in accordance with Section 01 71 23 - Field Engineering, to design the temporary supports. Such professional engineer shall be experienced with the type and size of subject Underground Facility, structural

engineering, and geotechnical engineering sufficient for the foundations of the temporary supports.

b. Temporary supports are not delegation of professional design responsibility unless expressly so indicated in the Contract Documents.

c. Responsibilities of Contractor's professional engineer shall include, but are not necessarily limited to, the following:

1) Advising Contractor on investigations necessary to obtain information for design of temporary supports. Reviewing and considering results of such investigations in the design of temporary supports.

2) Visiting the Site to make personal observations as needed.

3) Identify appropriate design criteria for temporary supports.

4) Preparing necessary calculations, design drawings, and design specifications (sealed and signed when required by Contract or Laws or Regulations), appropriately based on the associated soil conditions and subsurface conditions, considering the consequences of failure of the temporary supports and associated potential for damage or failure of the existing subject Underground Facility.

5) Design temporary supports with a safety factor of not less than 2.0.

6) Review and approve or take other appropriate action on submittals of shop drawings and product data for the temporary supports and related materials.

7) Make periodic visits to the Site during erection of the temporary supports and at appropriate intervals thereafter to inspect the temporary supports during performance of other, adjacent Work.

8) Issue to Contractor written recommendations for repairs and improvements necessary for the proper protection of the associated Underground Facility.

9) Submit to Contractor detailed, written recommendations for backfilling the excavation underneath and adjacent to the Underground Facility and for removing the temporary supports.

d. Contractor shall comply with the professional engineer's design of the temporary supports.

e. Owner may require and, in such event, Contractor shall submit, design documents, shop drawings, product data, and reports by Contractor-hired professional engineer. Do not submit such documents to Engineer. When such documents are furnished to Owner, the Owner has no obligation to perform any review of such documents and Owner's possession of such documents does not impart on Owner or Engineer any responsibility for or professional liability associated with design of such temporary supports and consequences of implementing such designs. Owner and Engineer are not obligated in any way to implement recommendations of Contractor's professional engineer.

3.6 PROTECTION OF EXISTING SURFACE STRUCTURES

A. Surface Structures – General:

1. Surface structures are existing buildings, structures, and other facilities at or extending above ground surface, including their foundations and any extension below ground surface. Surface structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage routes, exposed piping and utilities, poles, exposed wires and cabling, posts, signs, markers, curbs, walks, fencing, and other facilities visible at or above ground surface.

2. Protect surface structures as necessary and promptly remedy damage and defects resulting or arising from Contractor's operations. Unless expressly shown or indicated otherwise in the Contract Documents, protect such items regardless of whether shown or indicated on the Drawings or elsewhere in the Contract Documents.

3. Protection of Overhead Utilities:

a. Protect visible, overhead utilities, including electrical power, communications, and piped utilities, and related supports, regardless of whether such items are shown or indicated in the Contract Documents.
b. When required by the Contract Documents or when acceptable to owner of such utility or facility, temporarily relocate overhead utilities or facilities as necessary perform the Work.
c. Provide temporary barriers, barricades, and warning signs identifying overhead utilities within reach of Contractor's construction equipment, machinery, or operations.

B. Temporary Removals of Surface Structures:

1. Existing surface facilities, including but not limited to guard rails, handrails, posts, guard cables, signs, poles, markers, curbs, and fencing, that are temporarily removed to facilitate the Work shall be replaced and restored promptly after the associated Work is performed.
2. Replace and restore such items in accordance with the Contract Documents. If not addressed in the Contract Documents, replace and restore such items to preconstruction condition or better.
3. Remedy damage to all items temporarily removed and later replaced and restored.
4. All such temporary relocations, replacement, and restoration is at Contractor's cost.

C. Protection of Surface Structures:

1. Sustain in their original location and protect from direct and indirect injury all surface structures located within or adjacent to the Site. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure or facility.
2. Before proceeding with the Work of sustaining and supporting such structure or facility, Contractor shall, upon Engineer's request, promptly satisfy Engineer that methods and procedures to be used have been approved by party owning the surface structure or facility.
3. Regardless of approval or acceptance by owner of property, structure, or facility, responsibility for protecting the Work and property is solely Contractor's.

3.7 PROTECTION OF FLOORS, WALLS, AND ROOFS

A. Protection of Floors, Walls, and Roofs – General:

1. Use proper protective covering when moving equipment, handling materials or other loads, when painting, handling mortar or grout, and when cleaning walls, ceilings, or structure contents.
2. Use metal pans to collect oil and cuttings from piping, conduits, and rod threading machines, and under metal cutting machines.
3. Maintain at the Site and use spill kits and absorbent pads for remedying spills.
4. Do not load concrete floors less than 28 days after concrete placement without Engineer's written permission.
5. Do not load slabs, floors, walls, or roofs in excess of design loading.
6. Do not load roofs without Engineer's written permission.
7. Restrict access to roofs, and keep Contractor's workers and personnel off existing roofs, except as necessary for the Work.
8. If access to roofs is necessary, roofing, parapets, openings, and all other construction on or adjacent to roof shall be protected with suitable plywood, barricades, or other appropriate means.

3.8 PROTECTION OF INSTALLED MATERIALS, EQUIPMENT, AND LANDSCAPING

A. General:

1. Protect existing facilities and installed Work to prevent damage from subsequent operations.
2. Remove protective items when no longer needed, prior to Substantial Completion of the associated Work.

3. Where work will continue in adjacent area(s) after Substantial Completion of a portion of the Work, protect the substantially completed Work until all work in the area is complete.

B. Control traffic (foot traffic, wheeled items such as carts, vehicles, and other traffic) to prevent damage to equipment, materials, and surfaces.

C. Coverings:

1. Provide temporary coverings to protect materials and equipment from damage.
2. Cover: projections, wall corners and jambs, sills, and soffits of openings, in areas used for traffic and for passage of materials and equipment in subsequent work.
3. Fasten protective items without harming the Work. Use tape or adhesives that do not leave residue when removed.

END OF SECTION

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SECTION 01 73 20
OPENINGS AND PENETRATIONS IN CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Methods of installing and sealing openings and penetrations in construction.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 05 50 00 - Miscellaneous Metals.
2. Section 06 82 00 - Fiberglass Reinforced Plastic Fabrications.
3. Section 07 62 00 - Sheet Metal Flashing and Trim.
4. Section 07 84 00 - Firestopping.
5. Section 07 92 00 - Joint Sealants.
6. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   d. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   e. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   f. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
   g. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   h. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   i. A995, Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts.
2. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC):
      1) Article 501, Class 1 Locations.
   b. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
   c. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.3 DEFINITIONS

A. Corrosive Areas: For the purpose of this specification section, the following areas are defined as corrosive:

1. [_____].

B. Hazardous Areas: Areas shown in the Contract Documents as having Class I or Class II area classifications.

C. Washdown Areas: Areas having floor drains or hose bibbs.

1.4 SUBMITTALS

A. Shop Drawings:

1. For each structure provide dimensioned or scaled (minimum 1/8 inches = 1 foot) plan view drawings containing the following information:
   a. Vertical and horizontal location of all required openings and penetrations.
   b. Size of all openings and penetrations.
   c. Opening type.
   d. Seal type.
2. Manufacturer's installation instructions for standard manufactured products.

1.5 [PROJECT] [SITE] CONDITIONS

A. For purposes of this Project, water table level is elevation [_____].

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe Sleeves:

1. Areas listed as Corrosive Areas in PART 1:
   a. Stainless steel, Type [304L][316L].
   b. Penetrations 24 inches diameter or less: ASTM A269, ASTM A312 or ASTM A554, Schedule 40.
   c. Penetrations larger than 24 inches diameter: Stainless steel, ASTM A666, Minimum 1/4 inches thickness.
2. All other Areas:
   a. Steel, Hot-dipped galvanized after fabrication.
   b. Penetrations 24 inches diameter or less: ASTM A53, Schedule 40.
   c. Penetrations larger than 24 inches diameter: ASTM A36, Minimum 1/4 inches thickness.

B. Backing Rod and Sealant: See Specification Section 07 92 00.

C. Modular Mechanical Seals:

1. Products and Manufacturers: Subject to compliance with the Contract Documents, the following items and manufacturers are acceptable in the Work:
   a. Link-Seal, by Garlock.
   b. PipeSeal, by Flexicraft Industries.
   c. Or equal.
2. Materials:
   a. Modular Links: [EPDM rubber] [nitrile] [silicone].
   b. Hardware: [316 Type stainless steel] [galvanized steel].

D. Firestopping Material: See Specification Section 07 84 00.

E. Sheet Metal Sleeves:

1. Areas listed as Corrosive Areas in PART 1: Stainless steel: ASTM A240, Type [304L][316L].
2. All other areas: Galvanized steel: ASTM A653, G90.
3. Minimum 12 GA.

F. Commercial Wall Castings:

1. Ductile iron, ASTM A536.
2. Grade equal to connecting piping system.

PART 3 - EXECUTION

3.1 FABRICATION

A. Fabricate pipe sleeves in accordance with Specification Section 05 50 00.

B. Fabricate sheet metal sleeves in accordance with Specification Section 07 62 00.

C. Provide waterstop plate/anchor flange for piping, ducts, castings and sleeves cast-in-place in concrete.

1. For fabricated units, weld plate to sleeve, pipe, or ductwork.
2. For commercial castings, cast water stop/anchor with wall pipe.
3. Plate is to be same thickness as sleeve, pipe, casting or ductwork.
4. For fabricated units, diameter of plate or flange to be 4 inches larger than outside diameter of sleeve, pipe or ductwork.
5. For commercial castings, waterstop/anchor size to be manufacturer standard.
6. Provide continuous around entire circumference of sleeve, pipe, or ductwork.

D. Factory or shop-coat painted components in accordance with Specification Section 09 96 00.

3.2 INSTALLATION AND APPLICATION

A. Firestopping materials used in fire-resistance rated construction shall be in full compliance with Specification Section 07 84 00.

B. Seal openings and penetrations in non-fire-resistance-rated construction in accordance with Specification Section 07 92 00.

C. Obtain prior approval from Engineer when any opening larger than 100 square inches must be made in existing or newly completed construction.

D. Perform HVAC penetrations in accordance with NFPA 90A.

E. Perform electrical penetrations in accordance with NFPA 70, Article 501.

F. When mechanical or electrical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures or devices necessary to permit installation later.

1. Lay out chases, holes or other openings which must be provided in masonry, concrete or other work.

G. Where pipes, conduits or ducts pass through floors in washdown areas, install sleeves with top 3 IN above finish floors.

1. In non-washdown areas, install sleeves with ends flush with finished surfaces.

H. Size sleeves, blockouts and cutouts which will receive sealant seal such that free area to receive sealant is minimized and seal integrity may be obtained.

I. For insulated piping and ducts, size sleeves, blockouts and cutouts large enough to accommodate full thickness of insulation.

J. Where pipes, conduits or ducts pass through grating, provide banding at the entire perimeter of the opening.

1. Metal grating: See Specification Section 05 50 00.
2. FRP grating: See Specification Section 06 82 00.

K. Where pipes, conduits or ducts are removed where passing through grating:

1. Metal grating:
   a. Provide banding at perimeter and cover opening with 1/4 inches plate of the same material of the grating.
   b. See Specification Section 05 50 00.
2. FRP grating:
   a. Provide full depth cover meeting same loading requirement as existing material or replace grating section.
   b. See Specification Section 06 82 00.

L. Do not cut into or core drill any beams, joists, or columns.

M. Do not install sleeves in beams, joists, or columns.

N. Do not install recesses in beams, joists, columns, or slabs.

O. Field Cutting and Coring:

1. Saw or core drill with non-impact type equipment.
2. Mark opening and drill small 3/4 inches or less holes through structure following opening outline.
3. Sawcut opening outline on both surfaces.
   a. Knock out within sawcuts using impact type equipment.
   b. Do not chip or spall face of surface to remain intact.
   c. Do not allow any overcut with saw kerf.

P. Precast-Prestressed Concrete Construction:

1. Do not cut openings or core drill vertically or horizontally through stems of members.
2. Do not locate or install sleeves or recess sleeves vertically or horizontally through or in stems of members.
3. Cast openings and sleeves into flanges of units.
4. Cast openings larger than 6 inches in diameter or 6 inches maximum dimension in units at time of manufacture.
5. Cast openings smaller than 6 inches in diameter or 6 inches maximum dimensions in flanges of units at time of manufacture or field cut.

Q. Where alterations are necessary or where new and old work join, restore adjacent surfaces to their condition existing prior to start of work.

R. Where area is blocked out to receive sheet metal sleeve at later date:

1. If blockout size is sufficient to allow placement, utilize dowels for interface of initially placed concrete and sleeve encasement concrete which is placed later.
   a. Size blockout based on sleeve size required plus 4 to 6 inches each side of sleeve for concrete encasement.
   b. Provide #4 dowels at 12 inches spacing along each side of blockout with minimum of two dowels required per side.
2. If blockout size is not sufficient to allow placement of dowels, provide keyway along all sides of blockout.
   a. Size blockout based on sleeve size required plus 2 to 4 inches each side of sleeve for concrete encasement.

S. For interior wall applications where backer rod and sealant are specified, provide backer rod and sealant at each side of wall.

T. Refer to Drawings for location of fire-rated walls, floors, and ceilings.

1. Utilize firestopping materials and procedures specified in Specification Section 07 84 00 inches conjunction with scheduled opening type to produce the required fire rating.

U. Use full depth expanding foam sealant for seal applications where single or multiple pipes, conduits, etc., pass through a single sleeve.

V. Do not make duct or conduit penetrations below high water levels when entering or leaving tankage, wet wells, or other water holding structures.

W. Modular Mechanical Seals:

1. Utilize one seal for concrete thickness less than 8 inches and two seals for concrete, 8 inches thick or greater.
2. Utilize two seals for piping 16 inches diameter and larger if concrete thickness permits.
3. Install seals such that bolt heads are located on the most accessible side of the penetration.

X. Backer Rod and Sealant:

1. Install in accordance with Specification Section 07 92 00.
2. Provide backer rod and sealant for modular mechanical seal applications.
   a. Apply on top side of slab penetrations and on interior, dry side wall penetrations.

3.3 SCHEDULES

A. General Schedule of Penetrations through Floors, Roofs, Foundation Base Slabs, Foundation Walls, Foundation Footings, Partitions and Walls for Ductwork, Piping, and Conduit:

1. Provide the following opening and penetration types:
   a. Type A - Block out 2 inches larger than outside dimensions of duct, pipe, or conduits.
   b. Type B - Saw cut or line-drill opening. Place new concrete with integrally cast sheet metal or pipe sleeve.
   c. Type C - Fabricated sheet metal sleeve or pipe sleeve cast-in-place. Provide pipe sleeve with water ring for wet and/or washdown areas.
   d. Type D - Commercial type casting or fabrication.
   e. Type E - Saw cut or line-drill opening. Place new concrete with integrally cast pipe, duct or conduit spools.
   f. Type F - Integrally cast pipe, duct or conduit.
   g. Type G - Saw cut or line-drill and remove area 1 inch larger than outside dimensions of duct, pipe or conduit.
   h. Type H - Core drill.
   i. Type I - Block out area. At later date, place new concrete with integrally cast sheet metal or pipe sleeve.
   j. Type J - Grating Banding for any field cut openings.
2. Provide seals of material and method described as follows.
   a. Category 1 - Modular Mechanical Seal.
   b. Category 2 - Roof curb and flashing according to SMACNA specifications unless otherwise noted on Drawings. Refer to Specification Section 07 62 00 and roofing Specification Sections for additional requirements.
   c. Category 3 - 12 GA sheet metal drip sleeve set in bed of silicon sealant with backing rod and sealant used in sleeve annulus.
   d. Category 4 - Backer rod and sealant.
   e. Category 5 - Full depth compressible sealant with escutcheons on both sides of opening.

f. Category 6 - Full depth compressible sealant and flanges on both sides of opening. Flanges constructed of same material as duct, fastened to duct and minimum 1/2 inches larger than opening.

g. Category 7 - Full depth compressible sealant and finish sealant or full depth expanding foam sealant depending on application.

h. Category 8 - Banding for all grating openings and banding and cover plate of similar materials for abandoned openings.

3. Furnish openings and sealing materials through new floors, roofs, grating, partitions and walls in accordance with Schedule A, Openings and Penetrations for New Construction.

4. Furnish openings and sealing materials through existing floors, grating, roofs, partitions and walls in accordance with Schedule B, Openings and Penetrations for Existing Construction.

SCHEDULE A. OPENINGS AND PENETRATIONS SCHEDULE FOR NEW CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	C F I	7 Not Req 7	D F I (1)	Not Req Not Req 7	C F	7 Not Req
Through floors on grade above water table	C F I	4 Not Req 4	C F I (1)	7 Not Req 7	C F I (1)	4 Not Req 7
Through slab on grade below water table	F	Not Req	F	Not Req	F	Not Req
Through floors in washdown areas	C I	4 4	C H (2) I (1)	4 3 4	F H (2) I (1)	Not Req 3 7
Through walls where one side is a hazardous area	C F I	7 Not Req 7	D F I (1)	Not Req Not Req 7	C F	7 Not Req
Through exterior wall below grade above water table	C F I	7 Not Req 7	C D F I (1)	1 Not Req Not Req 1	F I (1)	Not Req 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	C F I	7 Not Req 7	C D F H (2)	1 Not Req Not Req 1	C F H (2) I (1)	7 Not Req 7 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	F	Not Req	F	Not Req	F	Not Req
Through exterior wall above grade	A B C	6 6 6	A B D H (2)	5 5 Not Req 5	C H (2)	5 4
Roof penetrations	A	2	A	2	A	2
Through interior walls and slabs not covered by the above applications	A C	4 4	A C	4 4	A C F	4 4 Not Req
Grating openings and penetrations	J	8	J	8	J	8

SCHEDULE B. OPENINGS AND PENETRATIONS SCHEDULE FOR EXISTING CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors with bottom side a hazardous location	B E	7 Not Req	B (1) E (3) H (2)	7 Not Req 7	B (1) E (3) H (2)	7 Not Req 7
Through floors on grade above water table	B	7	B	7	B	7
Through slab on grade below water table	E	Not Req	E	Not Req	E	Not Req
Through floors in washdown areas	G	3	G H (2)	3 3	G H (2)	3 3
Through walls where one side is a hazardous area	B E	7 Not Req	B (1) B (3) E H (2)	7 1 Not Req 7	B (1) (3) E H (2)	7 Not Req 7
Through exterior wall below grade above water table	B	7	B (1) B (3) H (2)	7 1 7	B (1) (3) H (2)	7 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	B E	7 Not Req	B E H (2)	1 Not Req 1	B (1) (3) E H (2)	7 Not Req 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	E	Not Req	E	Not Req	E	Not Req
Through exterior wall above grade	G	6	G (1) (3) H (2)	5 5	G (1) (3) H (2)	5 7
Roof penetrations	G	2	G (1) (3) H (2)	2	G	2
Through interior walls and slabs not covered by the above applications	G	4	G (1) (3) H (2)	4 4	G (1) (3) H (2)	4 4
Grating openings and penetrations	J	8	J	8	J	8

(1) Multiple piping 3 inches and smaller or multiple conduits.
(2) Single pipe 3 inches and smaller or single conduit.
(3) Single pipe or conduit larger than 3 inches.

END OF SECTION

SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for cutting and patching Work.

B. Scope:

1. Contractor shall perform cutting and coring, and rough and finish patching of holes and openings in existing construction.
2. Provide cutting, coring, fitting, and patching, including attendant excavation and fill, required to complete the Work, and to:
   a. remove and replace defective Work;
   b. remove samples of installed Work as specified or required for testing;
   c. remove construction required to perform required alterations or additions to existing construction;
   d. uncover the Work for Engineer's observation of covered Work, testing, or inspection by testing entities, or observation by authorities having jurisdiction;
   e. connect to completed Work not performed in proper sequence;
   f. remove or relocate existing utilities and piping that obstruct the Work in locations where connections are to be made;
   g. make connections or alterations to existing or new facilities.

C. Related Requirements:

1. Section 03 31 30 - Concrete, Materials and Proportioning.
2. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
3. Section 09 96 00 - High Performance Industrial Coatings.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:

1. Cutting and Patching Request:
   a. Submit written request to Engineer, well in advance of executing cutting or alteration that affects one or more of the following:
      1) Design function or intent of Project.
      2) Work of Owner or other contractors retained by Owner.
      3) Structural capacity or integrity of an element of the Project, building, or structure.
      4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
      5) Efficiency, operational life, maintenance, or safety of operational elements.
      6) Visual qualities of elements that will be exposed to view after completion of the Work.
   b. Request shall include:
      1) Identification of Project and Contract designation.
      2) Description of affected Work of Contractor and work of others (if any) retained by Owner.
      3) Necessity for cutting.

4) Effect on work or operations of Owner and other contractors (if any) retained by Owner, and on structural and weatherproof integrity of Project, building, or structure.
5) Description of proposed Work, indicating: scope of cutting and patching; trades that will execute the cutting and patching Work; materials and equipment to be used; extent of refinishing; schedule of operations; alternatives (if any) to cutting and patching, and net effect on aesthetics following completion of finishing Work.
6) Indication of entity responsible for cost of cutting and patching, when applicable.
7) Written permission of other prime contractors (if any) whose work will or may be affected.

2. Recommendation Regarding Cutting and Patching:
   a. Should conditions of work or schedule indicate a change of materials or specified methods, furnish Submit written recommendation to Engineer including:
      1) Conditions indicating change.
      2) Recommendations for alternative materials or alternatives to specified methods.
      3) Material manufacturer's printed recommendations for the proposed product and recommendations of manufacturer's technical representative for the specific application(s). The latter shall be on technical representative's letterhead and shall explicitly indicate the Project and specific cutting and patching application(s) to which the recommendation(s) apply.
      4) Items required with request for approval of substitute, in accordance with the substitution request requirements of the Contract Documents.
3. Product Data:
   a. Submit manufacturer's published data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.
   b. When not required under other Specifications sections, submit manufacturer's published data on materials to be used for finishing around the cut or patched area(s), together with indication of the location(s) where each is proposed for use.
   c. Furnish Submittals for patching materials under the associated Specifications section. Submittal to include letter of recommendation from product manufacturer's technical representative indicating on technical representative's letterhead, explicitly indicating:
      1) Project name and facility name;
      2) specific cutting and patching application(s) to which the recommendations apply;
      3) that product manufacturer's technical representative has personally observed and is familiar with conditions in the work area(s) of the subject cutting and patching;
      4) materials that are the subject of the Submittal are appropriate for the condition(s) of the proposed patch and will remain durable in the patch's final exposure upon Substantial Completion; and.
      5) patching material manufacturer's technical representative's recommendations for surface preparation, installation of patching material(s), and curing.

B. Informational Submittals: Submit the following:
   1. Written Notification of Cutting and Patching:
      a. Furnish as a Submittal written indication designating the day and time that the construction associated with cutting and patching will be uncovered to allow for observation. Do not begin cutting or patching operations until submittal is accepted by Engineer.
   2. X-ray Investigations:
      a. Proposed method of investigation. Submit and obtain Engineer's acceptance prior to performing x-ray inspections.
      b. Report of x-ray evaluation of slabs, floors, and walls to be cut or core-drilled.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials – General:

1. Provide materials that comply with the Contract Documents.
2. If not shown or indicated in the Contract Documents, use materials identical to existing materials affected by cutting and patching Work.
3. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, provide materials whose installed performance will equal or surpass that of existing materials.
4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties.

B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:

1. After core-drilling or sawcutting (as applicable) and before installing the utility or equipment through the penetration, coat exposed concrete and exposed steel with solvent-free, two-component, protective, epoxy resin coating.
2. Color shall approximate the finish color of the existing surface to be coated.
3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   a. Sikagard 62, by Sika Corporation.
   b. Or equal.

C. Grout Materials:

1. Comply with Section 03 31 30 - Concrete, Materials and Proportioning.

D. Epoxy Bonding Adhesive:

1. Provide two-component, moister-insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.
2. Comply with Section 03 31 30 - Concrete, Materials and Proportioning.
3. Product and Manufacturer: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   a. Euco No.452 MV by Euclid Chemical Co.
   b. Sikadur 32, Hi-Mod by Sika Corporation.
   c. Or equal.

E. Epoxy Patch Material:

1. Engage the manufacturer's representative to observe and recommend a suitable patching material of the actual construction conditions.
2. Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
   a. Depth of patch greater than 3/4 inches:
      1) Five Star MP Epoxy Patch.
      2) Or equal.
   b. Depth of patch between 1/8 inches and 3/4 inches:
      1) Five Star Fluid Epoxy.
      2) Or equal

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examination and Assessment – General:

1. Examine surfaces to be cut or patched, and conditions under which cutting or patching will be performed before starting cutting or patching Work.
2. Report unsatisfactory or questionable conditions to Engineer in writing.
3. Do not proceed with cutting or patching Work until unsatisfactory conditions are corrected.

B. Non-Destructive Investigation:

1. In advance of cutting or coring through existing slabs or walls, use x-ray or other non-destructive methods accepted by Engineer to determine location of reinforcing steel, electrical conduits, and other items embedded in slabs and walls.
2. Submit to Engineer written report of findings of evaluation.
3. Perform x-ray investigation and submit results to Engineer sufficiently in advance of cutting Work to allow time to identify and implement alternatives, if changes to the Work are necessary because of conduit or other features in floor or wall.

3.2 PREPARATION

A. Provide temporary support required to maintain structural integrity of facilities, to protect adjacent work from damage during cutting, and to support the element(s) to be cut.

B. Protection of Existing Construction during Cutting and Patching:

1. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project and facility that will be exposed during cutting and patching operations.
2. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
3. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.3 CUTTING AND PATCHING – GENERAL

A. Perform cutting and coring in such manner that limits extent of patching required.

B. Structural Elements:

1. Do not cut or patch structural elements in manner that would change the element's structural load-carrying capacity as load deflection ratio.

C. Operating Elements:

1. Do not cut or patch operating elements in manner that would reduce their capacity to perform as intended.
2. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.

D. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using methods that do not void required or existing warranties.

E. Provide adequate temporary covering over openings (whether cut or core-drilled) where not in use. Avoid creating tripping hazards for openings provided in floors and slabs.

3.4 CORING

A. Use core-drilling to make penetrations through concrete and masonry walls, slabs, or arches, unless otherwise accepted by Engineer in writing.

B. Coring:

1. Perform coring with non-impact rotary tool using diamond core-drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration.

2. Do not core-drill through electrical conduit or other utilities embedded in walls or slabs without approval of Engineer. To extent possible, avoid cutting reinforcing steel in slabs and walls.

C. Protection:

1. Protect existing equipment, utilities, and adjacent areas from water and other damage caused by or resulting from core-drilling operations.
2. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specification Section. Apply protective coating in accordance with manufacturer's instructions.

D. Cleaning:

1. After core-drilling, vacuum or otherwise remove slurry and tailings from the work area.

3.5 CUTTING

A. Cutting – General:

1. Cut existing construction using methods least-likely to damage elements retained and adjoining construction and that provide proper surfaces to receive subsequent installation or repair.
2. In general, use hand tools or small power tools suitable for sawing or grinding. When possible, avoid using hammering and avoid chopping. Carefully chip out concrete where necessary and as indicated in the Contract Documents.
3. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces.
4. Prior to starting cutting, provide adequate bracing of area to be cut.
5. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.
6. Use equipment of adequate size to remove the cut panel or "coupon".

B. Cutting – Concrete and Masonry:

1. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
2. On both sides of the element being cut, provide for control of slurry generated during sawing.
3. Concrete Cutting:
   a. Make openings by sawing through existing concrete. Core drill with 6 inches diameter core at the corners of openings to avoid overcutting at corners.
   b. When the cut-out concrete or "coupon" cannot be removed in one piece, or where concrete is too thick for saw to penetrate fully, break out concrete after initial saw cuts.
   c. Where saw cutting is not possible:
      1) Make openings by drilling holes around perimeter of required opening and subsequently carefully chip out concrete.
      2) Holes shall be sufficient in quantity to prevent damage to remaining concrete.
4. Sizing and Repair of Cut Concrete Surfaces:
   a. Where reinforcing steel is cut, remove existing reinforcing steel back to 1.5 inches below concrete surface. When using heat or torching to remove ends of reinforcing steel, remove adjacent, heat-damaged concrete prior to patching. Sides of resulting hole to be patched shall be approximately perpendicular to finished concrete surface. Provide bonding adhesive on surfaces of resulting holes and fill resulting holes with non-shrink grout in accordance with the Contract Documents.
   b. Oversize required openings in existing concrete by one inch on all sides and build back to required opening size by providing epoxy grout bonded to existing concrete.

c. Where oversizing the cut opening by one inch is not possible, cut the opening to the required dimensions. After cutting concrete and before installing subsequent construction on or through the opening, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Specifications Section. Apply protective coating in accordance with manufacturer's instructions.

d. Where indicated, finish remaining surfaces as indicated in Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

3.6 PATCHING

A. Patching – General:

1. Patch large openings to be filled with concrete in accordance with the Contract Documents. Before installing new concrete, apply bonding adhesive indicated in Paragraph 2.1.C of this Specifications section in accordance with manufacture's recommendations.
2. Where large openings to be filled with concrete are indicated on the Drawings as requiring reinforcing steel, provide reinforcing steel as shown and indicated in the Contract Documents. Where openings in existing reinforced concrete are larger than 2 feet in diameter or 2 feet by 2 feet and the Drawings or elsewhere in the Contract Documents do not expressly require reinforcing steel for the opening, submit a request for interpretation to Engineer and obtain Engineer's response before proceeding.
3. Where concrete infill or grout repair materials are not used, patch using epoxy patch material indicated in Paragraph 2.1.D of this section unless otherwise indicated on Drawings.
4. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work.
5. Patch with durable seams that are as inconspicuous as possible. Provide materials and comply with installation requirements indicated in the Contract Documents and the published installation instructions of the material's manufacturer.
6. Patch to provide airtight and watertight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
7. Where feasible, test patched areas to demonstrate integrity of installation.

B. Restoration:

1. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that eliminates evidence of patching and refinishing.
2. For continuous surfaces, refinish to nearest intersection.
3. For an assembly, refinish the entire unit that was patched.
4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 CLEANING

A. Cleaning and Restoration:

1. Perform cleaning promptly after associated cutting, coring, and patching.
2. Clean areas and spaces where cutting, coring, or patching were performed.
3. Clean piping, conduit, and similar constructions before applying paint or other finishing materials.
4. Restore damaged coverings of pipe and other utilities to original condition.

END OF SECTION

SECTION 01 74 00
CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for keeping the Site free of accumulations of waste materials during construction ("progress cleaning").
2. Cleaning for Substantial Completion and prior to final inspection (collectively, "closeout cleaning").

B. Scope:

1. Contractor shall perform cleaning during the Project, including progress cleaning, as condition precedent to Substantial Completion, upon completion of the Work, and as required by the General Conditions, as may be modified by the Supplementary Conditions, this Specifications section, and elsewhere in the Contract Documents.
2. Maintain in a clean manner the Site, the Work, and areas adjacent to or affected by the Work.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Fire Protection Association (NFPA):
   a. 241, Safeguarding Construction, Alteration, and Demolition Operations.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PROGRESS CLEANING

A. Progress Cleaning – General:

1. Clean the Site, work areas, and other areas occupied by Contractor not less than weekly. Dispose of waste materials in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and the following:
   a. Comply with NFPA 241 for removing combustible waste materials and debris.
   b. Do not hold non-combustible materials at the Site more than three days if the ambient air temperature is expected to rise above 80 degrees F. When ambient air temperature is less than 80 degrees F, dispose of non-combustible materials within seven days of their generation.
   c. Provide suitable containers for storage of waste materials and debris. Avoid generation of odors and creation of nuisances.
   d. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

B. Progress Cleaning – Site:

1. Keep outdoor, dust-generating areas wetted down or otherwise control dust emissions.
2. Not less than weekly, brush-sweep roadways and paved areas at the Site and adjacent areas used by construction vehicles or otherwise affected by construction activities.
3. Comply with dust control requirements of Section 01 57 05 - Temporary Controls.

C. Progress Cleaning – Work Areas:

1. Clean areas where the Work is in progress to maintain an extent of cleanliness necessary for proper execution of the Work and safety of personnel.
2. Remove liquid spills promptly. Where spills may have harmful effects on health, safety, protection of facilities, or the environment, immediately report spills to Owner, Engineer, and authorities having jurisdiction, in accordance with the Contract Documents and Laws and Regulations.
3. Where dust would impair proper execution of or quality of the Work, broom-clean or vacuum entire work area, as necessary.
4. Concealed Spaces: Remove waste material and debris from concealed spaces before enclosing the space.

D. Progress Cleaning – Installed Work:

1. Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of installed materials and equipment, using only cleaning agents and methods specifically recommended by material or equipment Supplier.
2. If Supplier does not recommend specific cleaning agents or methods, use cleaning agents and methods that are not hazardous to health and property and that will not damage or mar exposed surfaces.

E. Progress Cleaning – Exposed Surfaces:

1. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration until Substantial Completion.

F. Progress Cleaning – Cutting and Patching:

1. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, trailings and cuttings, and similar materials.
2. Comply with Section 01 73 29 - Cutting and Patching, regarding cleaning during and after cutting and patching Work.
3. Thoroughly clean piping, ductwork, conduits, and similar features before applying patching material, paint, or other finishing materials.
4. Restore damaged insulation and coverings on piping, cutwork, and similar items to its pre-construction condition.

G. Cleaning of Hydraulic Structures:

1. Clean hydraulic structures that will contain fluid, such as tanks and channels, in accordance with this Specifications section.
2. Do not perform field quality control activities such as testing tanks, channels, and other hydraulic structures for leakage or disinfecting (where applicable), and do not apply for inspection for Substantial Completion for hydraulic structures, until the associated hydraulic structures are clean and free of all waste materials, and ready for intended use.

H. Waste Disposal:

1. Properly dispose of waste materials (including surplus materials, debris, rubbish, and other waste) off the Site.
2. Do not burn or bury waste materials at the Site.
3. Remove waste material and rubbish from excavations before backfilling.
4. Do not discharge volatile or hazardous substances, such as mineral spirits, oil, or paint thinner, into storm sewers, gutters, sanitary sewers, or other location in the environment. Dispose of such materials in accordance with Laws and Regulations.
5. Do not discharge wastes to surface waters, drainage routes, or groundwater.
6. Contractor is solely responsible for complying with Laws and Regulations regarding storing, transporting, and disposing of waste generated by Contractor's operations or brought to the Site by Contractor.

I. During handling and installation of materials and equipment, clean and protect construction in progress and adjoining materials and equipment already in place. Apply protective covering where necessary or required for protection from damage or deterioration, until Substantial Completion.

J. Clean completed construction as frequently as necessary throughout the construction period.

3.2 CLOSEOUT CLEANING

A. Complete the following prior to requesting inspection for Substantial Completion:

1. Clean and remove from the Site waste material (including rubbish and debris) and other foreign and undesirable items and substances.
2. Sweep broom-clean paved areas suitable for access by vehicles.
3. Remove spills and stains or petroleum, oils, solvents, other chemicals, and other foreign and undesirable deposits.
4. Hose-clean sidewalks and loading areas.
5. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
6. Surface waterways and drainage routes (including storm sewers, gutters, and ditches) shall be open and clean.
7. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition; if condition is not specified, restore to preconstruction condition.
8. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign and undesirable substances.
9. Clean, wax, and polish wood, vinyl, and painted floors.
10. Remove waste material and surface dust from limited-access spaces, including roofs, plenums, shafts, trenchway, equipment vaults, manholes, and similar spaces.
11. In unoccupied spaces, sweep concrete floors broom-clean.
12. Clean transparent materials, including mirrors and glazing in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
13. Remove non-permanent tags and labels.
14. Surface Finishes:
    a. Touch-up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.
    b. Do not paint over “UL” or similar labels, including mechanical and electrical nameplates.
15. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint, and mortar droppings, and other foreign or undesirable substances.
16. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.
17. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
18. Clean lighting fixtures, lamps, globes, and reflectors to function with full efficiency. Replace temporary lamps provided in permanent fixtures. Replace existing lighting fixture components that are burned out or noticeably dimmed from use during construction. Replace defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
19. Leave the Site clean, and in neat, orderly condition, satisfactory to Owner and Engineer.

B. Complete the following prior to requesting final inspection:

1. After Substantial Completion of all the Work, following completion of items of incomplete or damaged Work (“punch list Work”), clean “punch list Work areas in accordance with Paragraph 3.2.A of this Specifications Section.

2. Remove field offices, Contractor's storage sheds, and remaining stockpiles and clean all such areas in accordance with Paragraph 3.2.B of this Specifications Section, and in accordance with Contract Documents for landscaping and restoration.

END OF SECTION

SECTION 01 75 00
CHECKOUT AND START-UP PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for checkout and startup of equipment, systems, and facilities.

B. Scope:

1. Contractor shall initially check out, start up, and place equipment and systems installed under the Contract into successful operation, in accordance with the material and equipment manufacturers' written instructions, Suppliers' recommendations at the Site, and the Contract Documents.
2. Provide the following:
   a. All labor, tools, materials, and equipment required to complete equipment and system checkout and startup.
   b. Chemicals, lubricants, and other required operating fluids necessary for checkout, startup, and initial operation of the Work.
   c. Filters and other temporary or consumable items necessary for checkout, startup, and initial operation of the Work.
   d. Fuel, electricity, water, and other temporary utilities and temporary facilities necessary for checkout and startup of equipment and systems, unless otherwise specified.
3. The General Conditions, as may be modified by the Supplementary Conditions, and Section 01 77 19 - Closeout Requirements, address requirements for documenting Substantial Completion.

C. Related Sections include but are not necessarily limited to:

1. Section 01 78 23 - Operation and Maintenance Data
2. Section 01 61 03 - Equipment - Basic Requirements.
3. Section 01 77 19 - Closeout Requirements.
4. Section 01 79 23 - Instruction of Operations and Maintenance Personnel.
5. Section 40 61 13 - Process Control Systems - General Requirements.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate checkout and startup with other contractors, as necessary.
2. Do not start up equipment or system(s) for continuous operation until all components of that equipment item or system, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
3. Subject to the constraints of this Specifications section, Owner will furnish sufficient personnel to assist Contractor in starting up equipment and system(s), but responsibility for proper operation of the Work is Contractor's.
4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to Engineer or otherwise required by the Contract Documents.
5. For startup of heating equipment, air conditioning equipment, and other equipment and systems that provide temperature control, that are dependent upon the time of year, return to the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate equipment and system(s).

6. Do not start up equipment and system(s), without submitting acceptable preliminary operations and maintenance manuals by Contractor in accordance with the Contract Documents.

B. Checkout and Startup Planning Meeting:

1. Contractor, with appropriate Subcontractors and Suppliers, shall attend and participate in a meeting with Owner, facility manager, and Engineer to discuss planning, scheduling, and coordination of checkout and startup activities.
2. Upon mutual concurrence of Owner, facility manager, Engineer, and Contractor, meeting may be concurrent with the training scheduling planning meeting required in Section 01 79 23 – Instruction of Operations and Maintenance Personnel.
3. Meeting shall be held by the earlier of: (1) not less than 60 days prior to first scheduled training session for the equipment and system(s) to be checked out and started-up, and (2) not less than 60 days prior to the checkout and startup of the associated equipment and system(s).
4. Attend meeting prepared to knowledgably and effectively discuss:
   a. Status of the Work and schedule-to-complete for requirements prerequisite to checkout and startup.
   b. Schedule for and status of training required for each equipment item and system.
   c. Schedule for checkout, startup, and field quality control activities for the subject Work.
   d. Status and quantities of required consumables, lubricants, and utility services necessary for checkout and startup.
5. Meeting will be chaired by Engineer. Engineer will prepare and distribute a record of topics discussed and decisions made during the meeting. If meeting is concurrent with the training planning meeting required under Section 01 79 23 - Instruction of Operations and Maintenance Personnel, Contractor shall chair and prepare minutes of the training scheduling planning portion of the meeting and furnish its draft minutes to Engineer to incorporate into the overall minutes.
6. Comply with decisions made at the meeting and the Contract Documents.

C. Sequencing:

1. Comply with Section 01 14 16 - Coordination with Owner's Operations, regarding staging (phasing) of the Work and allowable shutdowns.

D. Scheduling:

1. Progress Schedule:
   a. Clearly indicate in the Progress Schedule planned and actual dates for checkout, startup, and field quality control activities, including all demonstration testing activities addressed in this Specifications section and elsewhere in the Contract Documents. Separately indicate checkout, startup, and field quality control activities for each equipment item and system.
   b. Perform startup and field quality control activities on the associated, scheduled dates, unless otherwise acceptable to Owner, facility manager, and Engineer.
2. Restrictions for Scheduling:
   a. Checkout of materials, equipment, and systems by Contractor that do not involve or require Owner's or facility manager's personnel may be performed at any time during normal working hours. Where required by the Contract Documents or requested by Engineer, perform checkout in the presence of Engineer or Resident Project Representative (RPR).
   b. Startup, including initial operation of materials, equipment, and systems, shall not be initiated on: Monday, Friday, Saturday, Sunday, Owen's holidays, the day immediately prior to a holiday, or the day immediately following a holiday, unless otherwise acceptable to Owner, facility manager, and Engineer.

c. Unless otherwise indicated in the Contract Documents or acceptable to Owner, facility manager, and Engineer, perform all startup during normal working hours of the day shift.

d. To the extent practicable, where extended-duration startup or field quality control activities are required by the Contract, avoid having such activities extend into evening, night, weekend, or holiday hours.

e. Owner reserves the right to require a minimum seven days' notice of rescheduled startup when Contractor cannot perform the associated activities as scheduled.

3. Operation and Maintenance Data:

a. Comply with Section 01 78 23 - Operation and Maintenance Data.

b. A preliminary copy of all operation and maintenance manuals shall be received by Engineer prior to the start of the demonstration period.

4. Training:

a. Comply with Section 01 79 23 - Instruction of Operations and Maintenance Personnel.

5. Spare Parts, Tools, and Extra Materials.

a. Deliver to Owner or facility manager (as applicable) all required spare parts, tools, and extra materials prior to commencing the demonstration period, unless earlier delivery is required elsewhere in the Contract Documents.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Do not start up equipment or systems or place into initial operation until required operating permits are obtained from authorities having jurisdiction.

2. Where Owner (with or without assistance of Engineer) has applied for and obtained initial approvals or permits necessary for operation, Contractor shall furnish information and assistance to Owner or Engineer for Owner to secure final approvals from authorities having jurisdiction for required operating permits.

1.4 DEFINITIONS

A. The following defined terms are used in this Specifications Section:

1. Substantial Completion – Pumping Plant: Pumping Plant will be deemed substantially complete when a minimum of two pumps on both the low and high lift systems have completed their Pre-Demonstration and Demonstration Periods as defined below. Other non-process pumping plant improvements may follow Substantial Completion.

2. Substantial Completion – Traveling Screen: Traveling Screen will be deemed substantially complete when both the Pre-Demonstration and Demonstration Periods are completed and all associated civil, electrical and safety improvements are completed.

3. Instrumentation Supplier: Entity retained by Contractor, Subcontractor, or Supplier to furnish instrumentation or controls that will be part of the completed Work, including manufacturers, manufacturer representatives, wholesalers, retailers, and others, including entities retained to perform systems integration Work.

4. Project Classified System (PCS): An established, distinct part of the Project, consisting of an arrangement of items, such as equipment, structures, components, piping, cabling, materials, and incidentals, so related or connected to form an identifiable, unified, functional, operational, safe, and independent system. Two geographically separated PCSs have been defined for this project:

a. PCS 1 – Pumping Plant

1) All work associated with completion of a fully operational pumping plant to include:

a) Site clearing, demolition, civil, electrical, controls, mechanical, process mechanical, architectural and structural improvements associated with the Pumping Plant site to include, but not limited to; the new electrical building and associated generator enclosure and slab, propane generator, above ground propane storage tank and concrete slab and transformer vault construction.

b) Improvements to both the high and low lift irrigation distribution systems.

c) Testing, startup and final acceptance of a complete and operational pumping plant.

b. PCS 2 – Traveling Screen

1) All work associated with completion of a fully operational traveling screen and pedestrian bridge to include:

a) Site clearing, demolition, civil, electrical and structural and debris management area improvements, installation of new traveling screen and associated steel catwalk and railings, testing, startup and final acceptance of a complete and operational traveling screen.

b) Site clearing, demolition, civil and structural foundation construction and installation of a new FRP pedestrian bridge.

5. Pre-Demonstration Period: The period of time, of unspecified duration after initial construction and installation activities during which Contractor, with assistance from manufacturer's representatives, performs in the following sequence:

a. Finishing type construction work to ensure the Project has reached a state of Substantial Completion.

b. Equipment start-up.

c. Personnel training.

6. Demonstration Period: A period of time, of specified duration, following the Pre-Demonstration Period, during which the Contractor initiates process flow through the Project Classified Systems and starts up and operates the Project Classified System, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the Project Classified Systems as evidence of Substantial Completion.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Data collection and reporting log for each required Demonstration Period.
2. Plan for Pump Testing Water Supply and Recirculation System.

B. Informational Submittals: Submit the following:

1. Progress Schedules indicating dates for checkout, startup, and field quality control activates.
2. Completed checkout and startup log required in Paragraph 3.2.C of this Specifications section.
3. Manufacturer's installation check letters (also known as Manufacturer’s Field Services Report) required in Paragraph 3.2.C of this Specifications section.
4. Instrumentation Supplier’s Instrumentation Installation Certificate, required in Paragraph 3.2.C of this Specifications section.
5. Letter verifying completion of all pre-demonstration startup activities, required in Paragraph 3.2.C of this Specifications section.
6. Report of data collected during each required Demonstration Period.
7. Qualifications Statements:

a. Qualifications, including resume’ and copy of license, of Contractor-retained licensed operator.

1.6 COST OF STARTUP

A. Contractor shall pay all costs associated with testing and commissioning.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 CHECKOUT AND STARTUP – GENERAL

A. Facility Startup Divided into Two Periods:

1. Pre-Demonstration Period including:
   a. Obtain Engineer's approval or acceptance (as applicable) of Submittals required prior to checkout and startup, including all Shop Drawings, Samples, source quality control (shop testing) Submittals, preliminary operation and maintenance manuals, and other Submittals required by the Contract Documents, other than Submittals that cannot be furnished until after startup.
   b. Complete the Work to a point ready for checkout and startup, including operation available in all manual, automatic, and other modes.
   c. Checkout and initial field quality control activities that can be performed prior to startup of the equipment or system.
   d. Startup of the associated Work.
   e. Field quality control activities for the subject Work as indicated elsewhere in the Specifications and other Contract Documents, other than this section.
   f. Training of operations and maintenance personnel.
2. Demonstration Period, including:
   a. Demonstration of functional integrity of equipment, system, or PCS.

3.2 PRE-DEMONSTRATION PERIOD

A. Prior to the Pre-Demonstration Period, complete the Work to the point where it is ready for checkout and startup.

B. Checkout.

1. Comply with Section 01 61 03 - Equipment - Basic Requirements, including provisions concerning installation checks

C. Startup:

1. Comply with requirements for startup of materials, equipment, and systems indicated in the associated Specification sections and elsewhere in the Contract Documents.
2. Prepare the Work so it will operate properly and safely and be ready to demonstrate functional integrity during the Demonstration Period.
3. Perform startup to extent possible without introducing process flow, specifically:
   a. For the high lift pumping system, pump test flows will not be allowed to be discharged into the high lift irrigation distribution system. Contractor shall develop a recirculation system that returns water to the South Main Canal.
   b. For the low lift pumping system, pump test flows may be discharged into the low lift irrigation distribution system. If quantities of available water within the South Main Canal are insufficient for continuous testing, the Contractor shall develop a recirculation system that returns water to the South Main Canal.
4. Test pumping and similar equipment requiring a fluid, using clean water supplied as described below:
   a. The primary water source for pump testing will come from supplemental wells located adjacent and to the south of the South Main Canal Siphon upstream of the pumping plant.
      1) Contractor shall install a temporary cofferdam upstream of the traveling screen located on the upstream end of the South Main Canal Siphon to contain the test water within the canal.

b. The secondary water source for pump testing will come from diversion from Bannock Creek located adjacent and to the south of the South Main Canal Siphon upstream of the pumping plant.
    1) Contractor shall install a temporary cofferdam upstream of the traveling screen located on the upstream end of the South Main Canal Siphon to contain the test water within the canal.
c. Contractor shall notify Owner thirty (30) calendar days in advance of pump testing. Owner will operate the supplemental wells and will adjust the existing check dam in Bannock Creek as necessary to divert water. Contract shall not work within Bannock Creek.

5. Submit plan for pump testing water supply to Owner and RPR.
6. Introduce process flow to complete startup for the following:
    a. Low and High Lift Irrigation Pumping System.
7. Procedures include but are not necessarily limited to the following:
    a. Test or check and correct deficiencies of:
        1) Power, control, and monitoring circuits for continuity prior to connection to power source.
        2) Voltage of all circuits.
        3) Phase sequence.
        4) Cleanliness of connecting piping systems.
        5) Alignment of connected machinery.
        6) Vacuum and pressure of all closed systems.
        7) Lubrication.
        8) Valve orientation and position status for manual operating mode.
        9) Pumping equipment using process flow.
        10) Instrumentation and control signal generation, transmission, reception, and response.
            a) Comply with Section 40 61 13 - Process Control System General Requirements.
        11) Tagging and identification systems.
        12) Proper connections, alignment, calibration and adjustment.
    b. Calibrate safety equipment.
    c. Manually rotate or move moving parts to assure freedom of movement.
    d. “Bump-start” electric motors to verify proper rotation.
    e. Perform other tests, checks, and activities required to make the Work ready for Demonstration Period.
    f. Work Plan including Checkout and Startup Log:
        1) Prepare a work plan that includes a checkout and startup log showing each equipment item and system requiring checkout and startup. Indicate in the work plan activities to be accomplished during checkout and startup.
        2) Provide a place for Contractor to record date and person performing required checkout and startup. Indicate associated date(s), personnel, and employer of each.
        3) Submit completed checkout and startup log to Engineer and obtain Engineer’s acceptance.
        4) Work plan that includes a checkout and startup log shall be submitted and accepted 30 days prior to the Pre-Demonstration Period.
8. Obtain Suppliers’ certifications of the installed and operational Work, without restrictions, and submit to Engineer:

a. Manufacturer's installation check letters (sometimes referred to as Manufacturer's Field Services Report).
b. Instrumentation Supplier's Instrumentation Installation Certificate.

9. Letter verifying completion of all pre-demonstration startup activities including receipt of all specified items from Suppliers as final item prior to initiation of Demonstration Period.
10. Personnel Training:

3.3 DEMONSTRATION PERIOD

A. Demonstration Period – General:

1. Demonstrate the operation and performance of mechanical, electrical, instrumentation, and control interfaces of the Work undergoing the Demonstration Period, in accordance with the Contract Documents.
2. Duration of Demonstration Period: 120 consecutive hours.
3. If, during the Demonstration Period, the aggregate time used for repair, alteration, or unscheduled adjustments to any part of the Work that renders the affected Work inoperative or operation outside of recommended ranges exceeds 10% of the Demonstration Period, the demonstration of operation and performance will be deemed unacceptable and Contractor shall provide appropriate adjustments and remedies and re-perform the Demonstration Test, at no additional cost to Owner or facility manager, until acceptable results are obtained. Re-performance of the Demonstration Period shall comply with the same requirements as the original Demonstration Period.
4. Perform the demonstration of operation and performance of the Work under full operational conditions.
5. Owner's or Facility Manager's Personnel:
   a. Owner or facility manager (as applicable) will make available operations personnel to make process decisions affecting facility performance and compliance with applicable operating permits.
   b. Owner's or facility manager's assistance will be available only for process decisions.
   c. Contractor will perform all other functions associated with the Demonstration Period including but not limited to equipment operation and maintenance until successful completion of the Demonstration Period in accordance with the Contract Documents.
6. Owner or facility manager reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, and similar actions and events during the Demonstration Period to verify the operation and performance of the Work in automatic, manual, and other types of operating modes, backup systems, and alternate operating modes.
7. Prior to Starting Demonstration Period:
   a. Prepare data collection and reporting log for sampling, analytical data, and data to be obtained by manually recording data from field or panel indicators. Not less than 30 days prior to the start of the Demonstration Period, submit the data collection and reporting log to Engineer for acceptance.
8. Timing of Start and End of Demonstration Period:
   a. Schedule the end of the Demonstration Period at a convenient time such as midnight, so the Owner or facility manager can assume operational responsibility on a new day beginning immediately after completion of the Demonstration Period.
   b. Time of beginning and ending Demonstration Period shall be agreed upon by Contractor, Owner (and facility manager, if other than Owner), and Engineer in advance of initiating Demonstration Period.

B. Demonstration Period, Evaluation, and Acceptance:

1. Throughout the Demonstration Period, provide knowledgeable personnel to answer Owner's or facility manager's questions, provide final field instruction on select systems (where appropriate) and to respond to problems or failures of the Work.

2. Responsibilities for Sampling and Data Collection:
   a. Use the data collection and reporting log format accepted by Engineer. Indicate data clearly and legibly.
3. Responsibilities for Data Reporting:
   a. Submit data collected to Engineer for evaluation of acceptability of results.
4. Data Evaluation:
   a. Engineer, in consultation with Owner and facility manager (as applicable) as necessary, will evaluate the data collected during the Demonstration Period and other information obtained during the Demonstration Period for compliance with the Contract Documents.
   b. Engineer will advise Contractor in writing of whether the data and information obtained indicate that the Demonstration Period was successfully completed.
5. Criteria for Acceptance:
   a. If any equipment, during the Demonstration Period, fails to operate within the specified range, the Contractor shall address or repair the issue as necessary and repeat the Demonstration Period in its entirety.

END OF SECTION

SECTION 01 77 19
CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for:

1. Substantial Completion.
2. Final inspection.
3. Request for final payment and acceptance of the Work.

1.2 SUBSTANTIAL COMPLETION

A. Substantial Completion – General:

1. Prior to requesting inspection for Substantial Completion, perform the following for the substantially completed Work:
   a. Materials and equipment for which Substantial Completion is requested shall be fully ready for their intended use, including full operating and monitoring capability in automatic, manual, and other operating modes set forth in the Contract Documents.
   b. Permanent provisions for safety and protection, shown and indicated in the Contract Documents and associated with the substantially completed Work or for personnel accessing and using the substantially completed Work, shall be in place and ready for their intended use.
   c. Complete field quality control Work, including inspections and testing at the Site, indicated in Specifications sections for individual materials and equipment items and related Contract Documents. Submit results of, and obtain Engineer's acceptance of, field quality control tests and inspections required by the Contract Documents.
   d. Complete checkout and startup in accordance with Section 01 75 00 - Checkout and Startup Procedures, requirements of the Specifications for the various materials and equipment in the substantially completed Work, and related Contract Documents.
   e. Cleaning for Substantial Completion shall be completed in accordance with Section 01 74 00 - Cleaning.
   f. Training of the facility's operations and maintenance personnel shall be completed in accordance with the Contract Documents, including Section 01 79 23 - Instruction of Operations and Maintenance Personnel.
   g. Submit and obtain Engineer's acceptance of final operations and maintenance manuals in accordance with Section 01 78 23 - Operation and Maintenance Data.
   h. Obtain and submit to Engineer all required permits, inspections, and approvals of authorities having jurisdiction for the substantially completed Work to be occupied and used by Owner.
   i. Complete other tasks that the Contract requires be completed prior to Substantial Completion.
2. Procedures for requesting and documenting Substantial Completion are in the General Conditions, as may be modified by the Supplementary Conditions.

3. Sample letter for Contractor's request for inspection for Substantial Completion is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project and the needs of Contractor's request.
4. Unless decided otherwise by Owner and Engineer, form of certificate of Substantial Completion will be EJCDC C-625, "Certificate of Substantial Completion" (2018 edition or later), prepared by Engineer.

1.3 FINAL INSPECTION

A. Final Inspection – General:

1. Prior to requesting final inspection, verify that all the Work is fully complete and ready for final payment. Partial checklist for this purpose is attached to this Specifications section.
2. Sample letter for Contractor to request final inspection is attached to this Specifications section. Use the model language of the sample letter, modified to suit the Project.
3. Procedures for requesting and documenting the final inspection are in the General Conditions, as may be modified by the Supplementary Conditions, and as augmented in this Specifications section.

1.4 REQUEST FOR FINAL PAYMENT AND ACCEPTANCE OF THE WORK

A. Procedure:

1. After successful completion of the final inspection, submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplementary Conditions, and using procedure specified in Section 01 29 76 - Progress Payment Procedures, and this Specifications section.
2. Acceptance of the Work:
   a. Upon Engineer's concurrence that the Work is complete and ready for final payment (as a result of the final inspection and other communications between the parties and Engineer) and receipt of the final Application for Payment, accompanied by other required Contract closeout documentation, all in accordance with the Contract Documents, Engineer will issue to Owner and Contractor a notice of acceptability of the Work, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
   b. Unless decided otherwise by Owner and Engineer, form of acceptance will be EJCDC C-626, "Notice of Acceptability of Work", (2018 edition or later).
   c. Nothing other than receipt of such notice of acceptability from Engineer constitutes acceptance of the Work.
   d. Receipt of Engineer's notice of acceptability of the Work does not relieve Contractor of Contractor's continuing obligations under the Contract, including correction period obligations, warranty obligations, indemnification obligations, insurance requirements, and Contractor's other obligations following acceptance of the Work by Engineer and final payment. Such obligations shall commence and remain in effect as indicated elsewhere in the Contract Documents.

B. Request for final payment shall include:

1. Documents required for progress payments in Section 01 29 76 - Progress Payment Procedures.
2. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.

3. List, on Contractor's letterhead, of all Change Proposals, Claims, and disputes that Contractor believes are unsettled. If there are no such Change Proposals, Claims, or disputes, so indicate in writing.
4. Consent of Surety:
   a. Acceptable form includes Standard Form (SF)1414, "Consent of Surety", or other form acceptable to Owner.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The documents listed below, following this Specification section's "End of Section" designation, are part of this Specifications section:
   1. Sample letter for Contractor's use in requesting inspection for Substantial Completion (two pages).
   2. Sample partial checklist to identify readiness for final inspection (four pages).
   3. Sample letter for Contractor's use in requesting final inspection (one page).

B. In the model language of the attached sample letters for Contractor to request inspection for Substantial Completion and the final inspection, bracketed language, e.g., "insert date" indicates instructions to the drafter of the letter and often indicates specific information to be inserted by Contractor; do not include bracketed text in the final version of the letter(s) prepared for the Project. Some bracketed language is optional language; use the appropriate language to complete the actual letter for the Project and edit where required to suit the specific circumstances.

END OF SECTION

SAMPLE LETTER FOR CONTRACTOR'S USE IN
REQUESTING INSPECTION FOR SUBSTANTIAL COMPLETION

SENT VIA E-MAIL AND U.S. CERTIFIED MAIL/RETURN RECEIPT REQUESTED

HDR

Subject:

Request for Inspection for Substantial Completion

Dear addressee:

In our opinion, all of the Work under the above-referenced Contract is substantially complete as of insert month, day, year on which Substantial Completion was achieved. The specific portion of the Work that we believe is substantially complete is [insert identification of that portion of the Work that is substantially complete].

Enclosed is our listing of uncompleted Work items ("punch list"). In accordance with Paragraph 15.03.A of the General Conditions, we hereby request: (1) That the Engineer schedule and perform the inspection for Substantial Completion as soon as possible, and (2) Issuance of the certificate of Substantial Completion.

In accordance with Paragraph 15.03.D of the General Conditions, upon Substantial Completion, we propose the following relative to apportionment of responsibilities between the Owner and the Contractor:

1. Security, Protection, Insurance:
    a. Site Security: [insert proposal; address whether Owner or Contractor will be responsible for security of the Site].
    b. Protection of the Substantially Completed Work: [insert proposal; address whether Owner or Contractor will be responsible for protection].
    c. Property Insurance: [insert proposal; typically Owner assumes responsibility for property insurance upon Substantial Completion]
2. Operation and Maintenance:
    a. Operation: [insert proposal; address whether Owner or Contractor will be responsible for operating the substantially completed Work].
    b. Maintenance: [insert proposal; address whether Owner or Contractor will be responsible for maintaining the substantially completed Work].
3. Utilities: [for each of the following, indicate whether Owner or Contractor will be responsible for utilities and services, or whether responsibility will be shared; if shared, indicate proposed cost-sharing]
    a. Electricity: [insert proposal].

b. Natural Gas/Fuel/Heating: [insert proposal].

c. Water Supply: [insert proposal].

d. Wastewater: [insert proposal].

e. Communications (Telephone, Internet, Video): [insert proposal].

In accordance with Paragraph 15.08.A of the General Conditions, we understand that the Contract's correction period for the Work covered by the certificate of Substantial Completion commences on the Substantial Completion date documented in said certificate. [Drafter: Also see Paragraph 15.04 ("Partial Utilization") of the General Conditions and, where necessary, edit this paragraph of the letter accordingly.]

Should you have questions or comments regarding this notice, please contact [the undersigned] [or] [insert other contact person's name], at [insert telephone number and e-mail address].

Sincerely,

[Contractor's company name]

[Signatory name]
[Signatory's title]

Attachments:
Preliminary list of uncompleted Work items ("punch list"; [##] pages)

Copies:
[Owner's project manager]

SAMPLE PARTIAL CHECKLIST TO IDENTIFY READINESS FOR FINAL INSPECTION

Project: [_____]
Contract: [_____]
Contractor: [_____]

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
1. All Submittals, including all Shop Drawings and Samples, approved or accepted by Engineer	☐		☐	☐	☐		
Remarks:							
1. Final services completed by Suppliers, including submittal of "Manufacturer Field Service Report" in Section 01 61 03 Equipment - Basic Requirements	☐		☐	☐	☐		
Remarks:							
2. Final Work completed by Subcontractors	☐		☐	☐	☐		
Remarks:							
3. Permits closed out and regulatory compliance transitioned from construction to operations	☐		☐	☐	☐		
Remarks:							
4. All outstanding change issues are addressed and all Change Proposals submitted	☐		☐	☐	☐		
Remarks:							

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
5. All Change Proposals and Claims are resolved	☐		☐	☐	☐		
Remarks:							
6. All defective Work of which Contractor is aware has been corrected in accordance with the Contract Documents	☐		☐	☐	☐		
Remarks:							
7. Issues related to Constituents of Concern and potential Hazardous Environmental Condition have been fully addressed	☐		☐	☐	☐		
Remarks:							
8. All spare parts, tools, and extra materials have been furnished in accordance with the Contract Documents, and documentation thereof submitted to Engineer	☐		☐	☐	☐		
Remarks:							
9. All final operations & maintenance manuals have been submitted and accepted by Engineer	☐		☐	☐	☐		
Remarks:							
10. Manufacturer warranties and software license(s) furnished	☐		☐	☐	☐		
Remarks:							

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
11. Instruction and training of operations and maintenance personnel is complete and records of training submitted	☐		☐	☐	☐		
Remarks:							
12. MBE/WBE/DBE/VBE compliance report(s) submitted (when applicable)	☐		☐	☐	☐		
Remarks:							
13. All field engineering Submittals, including survey data, furnished	☐		☐	☐	☐		
Remarks:							
14. All Work on “punch list” is complete in accordance with the Contract Documents	☐		☐	☐	☐		
Remarks:							
15. All record documents submitted to and accepted by Engineer	☐		☐	☐	☐		
Remarks:							
16. Contractor is fully demobilized from the Site	☐		☐	☐	☐		
Remarks:							
17. All Site restoration is complete	☐		☐	☐	☐		
Remarks:							

Item No./Description	Completed/Date		In Progress	Not Started	Not Applicable	Target Date	Responsible Entity/Person
18. Final cleaning of all work areas is complete	☐		☐	☐	☐		
Remarks:							
19. Releases of Liens and waivers of Lien rights (or acceptable alternative) obtained from Subcontractors and Suppliers	☐		☐	☐	☐		
Remarks:							
20. Evidence of Contractor liability insurance furnished for correction period	☐		☐	☐	☐		
Remarks:							
21. All other required Contract closeout documents obtained	☐		☐	☐	☐		
Remarks:							
Remarks:							
22. All other Work and documentation required prior to final payment is complete and provided in accordance with the Contract Documents	☐		☐	☐	☐		
Remarks:							

SAMPLE LETTER FOR CONTRACTOR'S USE IN REQUESTING FINAL INSPECTION

SENT VIA E-MAIL AND U.S. CERTIFIED MAIL/RETURN RECEIPT REQUESTED

[Date]

[Name of Engineer's contact person]
HDR
[Street address]
[City, state, postal code]

Subject:
[Project name, Contract designation]
Request for Final Inspection

Dear [addressee]:

The Work under the above-referenced Contract is complete and ready for final payment as of [insert month, day, year on which final completion was achieved]. In accordance with Paragraph 15.05 of the General Conditions, we hereby request that the Engineer schedule and perform the final inspection as soon as possible. Upon successful completion of the final inspection, we will submit our final Application for Payment accompanied by the required Contract closeout documentation in accordance with the Contract Documents.

Should you have questions or comments regarding this notice, please contact [the undersigned] [or] [insert other contact person's name], at [insert telephone number and e-mail address].

Sincerely,

[Contractor's company name]

[Signatory name]
[Signatory's title]

Attachments:
None

Copies:
[Owner's project manager]

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Contractor-furnished, manufacturers' operation and maintenance (O&M) data, including:
   a. Required operation and maintenance data groupings into operation and data manuals and timing of such Submittals.
   b. Requirements for paper copies of operation and maintenance data and related Electronic Documents.
   c. Content of operation and maintenance data Submittals.

B. Scope:

1. Contractor shall submit operation and maintenance data, and related information, in accordance with this Section and requirements elsewhere in the Contract Documents, as instructional and reference information for use by: (a) Owner's operation and maintenance personnel, and (b) others retained by or working for Owner.
2. In addition to operation and maintenance data expressly required elsewhere in the Contract Documents, also submit operation and maintenance data for:
   a. All equipment and systems, including HVAC equipment, electrical equipment, communications equipment, electronic safety and security systems, utility equipment and other equipment.
   b. Valves, pumps, pump motors, traveling screen and related accessories.
   c. Instrumentation and control devices and systems.
   d. Building materials, systems, and finishes that need post-construction troubleshooting, cleaning, or maintenance, such as roofing, doors, windows, louvers, flooring, lighting, paint and coatings, safety equipment other finishes, and other items.

C. Related Requirements:

1. Section 01 31 26 - Electronic Communication Protocols.
2. Section 01 33 00 - Submittal Procedures.
3. Section 01 75 00 - Checkout and Startup Procedures.
4. Section 01 78 36 - Warranties.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
   a. Submit operation and maintenance data, required by the Contract Documents, grouped into operation and maintenance manual Submittals indicated in Table 01 78 23-A.
   b. Where operation and maintenance data required by the Contract Documents, is not expressly indicated in table 01 78 23-A, obtain written clarification or interpretation from Engineer prior to preparing and transmitting such Submittal.

c. For each required operation and maintenance manual Submittal, furnish preliminary Submittal and final Submittal. Timing of preliminary and final operation and maintenance manual Submittals, and differences between preliminary and final Submittals, are indicated in this Section.

Table 01 78 23-A
Required Groupings of Operation and Maintenance Data Submittals

Name of O&M Manual/Data	For Materials or Equipment Specified in Section(s)
Pumping Plant Process Equipment	43 24 05, 22 15 00, 40 05 52, 40 05 64, 40 05 66, 26 05 09
Electrical Equipment	26 24 19, 26 29 23, 26 32 15
HVAC and Ventilation Equipment	23 34 00, 23 80 00, 23 09 00
Traveling Screen Equipment	46 21 11
Bridge Crane Equipment	41 22 13

B. Timing of Submittals and Quantity Required:

1. Preliminary Operation and Maintenance Manual Submittals:
   a. Paper Copies: Three copies, exclusive of copies required for Contractor's use.
   b. Electronic Documents: In accordance with Section 01 31 26 - Electronic Communication Protocols.
   c. Submit to entity indicated in Section 01 33 00 – Submittal Procedures, by the earlier of: 90 days following approval of Shop Drawings and product data Submittals, or 14 days prior to starting training of operation and maintenance personnel, or 14 days prior to field quality control testing at the Site.
   d. Do not perform checkout, startup, and training without Engineer's acceptance of preliminary operation and maintenance data Submittals for the associated Work.
2. Final Operation and Maintenance Manual Submittals: Furnish final Submittal prior to Substantial Completion of the associated Work, unless submittal is required prior to an interim Milestone.
   a. Paper Copies: Three copies, exclusive of copies required for Contractor's use.
   b. Electronic Documents: In accordance with Section 01 31 26 - Electronic Communication Protocols.
   c. Work will not be eligible for Substantial Completion until associated, required final operation and maintenance data Submittals are accepted by Engineer.
   d. If Contractor (whether or not via Subcontractor or Supplier), revises program code or configuration files between acceptance of Submittal by Engineer and end of the Contract's correction period and Contractor's general warranty obligation, furnish updated program code and configuration files to Owner. Before modifying program code and configuration files after Substantial Completion, verify with facility manager that Owner- or facility manager modifications of program code or configuration files were incorporated into the modified files, subject to the provisions of this Section.

1.3 PAPER COPIES OF O&M MANUALS

A. Binding and Cover:

1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy, as necessary.
2. Binders shall be not less than one inch wide and maximum of three inches wide. Binders for each copy of each volume shall be same size and color.
3. Binders shall be locking three-ring (”D”-ring) type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front and back of each volume.
4. Do not overfill binders.
5. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.
6. Indicate the following information on cover of each volume:
   a. Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”. For submittal of preliminary operation and maintenance data, include the word, “PRELIMINARY” in the title.
   b. Name or type of material or equipment covered in the manual.
   c. Volume number, if more than one volume is submitted, listed as “Volume _____of _____”, with appropriate volume-designating numbers filled in.
   d. Name of Project and, when applicable, Contract name and number.
   e. Name of building or structure, as applicable.
7. Provide the following information on spine of each volume:
   a. Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”. For submittal of preliminary operation and maintenance data, include the word, “PRELIMINARY” in the title.
   b. Name or type of material or equipment covered in the manual.
   c. Volume number, when more than one volume is submitted, listed as “Volume _____of _____”, with appropriate volume-designating numbers filled in.
   d. Project name and building or structure name.

B. Pages:

1. Print pages in paper copies of operation and maintenance manuals on 30-pound (minimum) paper, 8.5-inch by 11-inch size.
2. Reinforce binding holes in each individual paper sheet with plastic, cloth, or metal. When published, separately-bound booklets or pamphlets are part of manuals, reinforcing of pages within booklet or pamphlet is not required.
3. Furnish each page with binding margin not less than 3/4-inch wide.
4. Properly punch each paper page with holes suitable for associated binding. Provide not less than 3/8-inch of paper between outer edge of punched holes and edge of paper. Manuals with improperly punched holes will be returned to Contractor as unacceptable.
5. In paper copies of manuals, each page in each copy shall be properly bound-through by the binder’s rings or posts. Paper manuals where some pages are not so bound will be returned to Contractor as unacceptable.

C. Drawings:

1. Bind into operation and maintenance manuals drawings, diagrams, and illustrations up to and including 11-inch by 17-inch size, with reinforcing and punched holes specified for paper pages.
2. Drawings or sheets larger than 11-inch by 17-inch shall be:
   a. Paper Copies: Neatly folded and inserted into clear plastic pockets bound into the manual. Neatly and permanently label each pocket with printed text indicating content and drawing numbers. Include not more than two drawings or sheets per pocket.
   b. Electronic Documents Copies: Included in electronic file at appropriate location.

D. Copy Quality and Document Clarity:

1. Provide original-quality copies. Documents in operation and maintenance manuals shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals with copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable.
2. Clearly mark, using ink, to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished and cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.

E. Organization:

1. Indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

1.4 ELECTRONIC DOCUMENTS O&M MANUALS

A. Electronic Documents of Operation and Maintenance Manuals:

1. Each Electronic Document copy of operation and maintenance data shall include all information included in the corresponding paper copy.
2. Submit Electronic Documents operation and maintenance data in accordance with Section 01 31 26 - Electronic Communication Protocols, and Section 01 33 00 - Submittal Procedures.
3. File Format:
   a. Unless otherwise required by Section 01 31 26 - Electronic Communication Protocols, or Section 01 33 00 - Submittal Procedures, operation and maintenance data Electronic Documents shall be “portable document format” (PDF) files.
   b. Electronic Documents shall be electronically searchable upon delivery.
   c. Electronic Documents shall not be password-protected and shall not be protected against Owner’s or facility manager’s copying and printing such files for Owner’s or facility manager’s use in operating and maintaining the facility.
   d. Electronic Documents shall open to its first page.
   e. Submit each operation and maintenance manual as a single Electronic Document file, unless file size is over-large, in which case divide into as few separate files, each with similar filename, as possible.

f. Within each Electronic Document, provide bookmarks for the following:
   1) Each chapter and subsection indicated in the corresponding printed copy document's table of contents.
   2) Each figure.
   3) Each table.
   4) Each appendix and attachment.

1.5 CONTENT OF OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance Manual Content – General:

1. Prepare each operation and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-constructed drawings as applicable, bills of materials, technical information, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.
2. Provisions of this Article were written for equipment. Where operation and maintenance data are required for building products, such as finishes, openings, thermal and moisture protection, and similar items, comply with this Article to the extent practical and reasonable for the associated item.
3. Completeness and Accuracy:
   a. Operation and maintenance manuals that include language stating or implying that the manual's content may be insufficient or stating that the manual's content is not guaranteed to be complete and accurate are unacceptable.
   b. Operation and maintenance manuals shall be complete and accurate.
   c. Operation and maintenance manuals shall indicate the specific alternatives and features furnished, and the specific operation and maintenance provisions for the material or equipment furnished.
4. Provide dividers and Include manufacturer's information, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where published documents, included in operation and maintenance data, pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.
5. Identify each equipment item consistent with names and identification numbers shown or indicated in the Contract Documents, rather than manufacturer's model numbers.
6. Neatly type data not furnished in computer-printed text. Handwriting, except for strikeouts, arrows, and the like, is unacceptable.
7. Include copy of warranty in accordance with the Contract Documents, including Section 01 78 36 - Warranties.
8. Include copy of proposed service contract, when applicable.
9. When copyrighted material is used in operation and maintenance manuals, obtain¬ copyright holder's written permission to use such material in the operation and maintenance manual.

B. Differences Between Preliminary and Final Operation and Maintenance Manuals:

1. In preliminary operation and maintenance manuals, include flysheet or placeholder for information to be included in final operation and maintenance manual Submittal.
2. In final operation and maintenance manuals, include information such as the following, as applicable for the associated materials and equipment:
   a. Equipment data that requires collection after startup, for example: (1) system and equipment balancing reports, including those for HVAC systems; and (2) final settings for electrical switchgear, automatic transfer switches, and circuit breakers: and (3) materials and equipment field testing results.
   b. Equipment startup reports and Suppliers' field service reports (the latter on form in Section 01 75 00 - Checkout and Startup Procedures).

C. Initial Documents in Operation and Maintenance Manuals:

1. Table of Contents:
   a. Provide table of contents in each volume of each operation and maintenance manual.
   b. In table of contents and not less than once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identifying items is unacceptable.
2. Equipment Record:
   a. Provide "Equipment Record" section of operation and maintenance manual immediately following the table of contents. "Equipment Record" section is not required for operation and maintenance data for other than equipment (such as building materials and finishes).
   b. Provide "Equipment Record" on forms included as this Section's Attachments 1, 2, and 3.
   c. For instrumentation and control equipment, International Society of Automation (ISA) data sheets are acceptable in lieu of the forms included as this Section's Attachments 1, 2, and 3.
   d. This Section's Attachments 1, 2, and 3 are available from Engineer as "fillable PDF forms".
   e. Complete in detail each section of "Equipment Record". Merely referencing the associated equipment's operation and maintenance data for nameplate, maintenance, spare parts, lubricants, or other required information, is unacceptable.
   f. For equipment or systems with multiple, separate components (for example, motor and gearbox), fully completed "Equipment Record" is required for each component.
   g. Operation and maintenance data Submittals without complete and accurate "Equipment Record" sheets are unacceptable.
3. Supplier's Field Service Reports:
   a. Include in final operation and maintenance manuals copies of associated Supplier's field services reports in accordance with Section 01 75 00 - Checkout and Startup Procedures.
   b. Include Supplier's completed field service reports in operation and maintenance manual in section immediately following "Equipment Record" section.

D. Operation and Maintenance Instructions:

1. Safety Considerations:
   a. Submit written descriptions of safety considerations relating to operation and maintenance procedures for materials and equipment.
   b. Describe safety devices and alarms provided with materials and equipment and proper operation and use.
   c. Indicate procedures for proper, safe operating and maintenance of materials and equipment furnished, including manufacturer's recommended personal protection equipment, apparatus, and devices not furnished under the Contract.
   d. Describe recommended safety-related training for personnel operating and maintaining the subject materials or equipment.
   e. Include in appendix to operation and maintenance manual manufacturers' relevant "safety data sheets" (SDS), formerly "material safety data sheets" (MSDS).
   f. Engineer's review of operation and maintenance data expressly does not extend to adequacy, completeness, and accuracy of SDS or other safety and protection practices and procedures indicated in the operation and maintenance data.
2. Operation:
   a. Include in operation and maintenance data Submittals complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; and regulation and control. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
   b. Include pre-startup instructions and checklists and complete startup instructions for each material and equipment item.
   c. Indicate recommended operating instructions for all operating modes and conditions, with associated recommendations for safe operation.
   d. Explain available controls and instrumentation and associated function(s).
   e. Indicate required shutdown checklists and procedures for: normal shutdown, emergency shutdown, and long-term shutdowns.
   f. Troubleshooting instructions.
3. Maintenance – General:
   a. Include in operation and maintenance data complete, written instructions for necessary and recommended maintenance, including mechanical maintenance and electrical/instrumentation and controls maintenance, as applicable.
   b. Include in operation and maintenance data complete instructions for necessary assembly, disassembly, installation, re-installation, storage, and shipping for materials and equipment.
   c. Tools: Include list of required maintenance tools and equipment.
   d. Spare Parts and Extra Materials:
      1) Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
      2) Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of

material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.

3) Also refer to this Article's provision, "Bills of Materials", below, for additional requirements regarding ordering replacement parts.

4. Routine and Preventative Maintenance:
   a. Submit complete, detailed, written instructions for routine and preventive maintenance including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
      1) Written explanations with illustrations for each routine and preventive maintenance task such as inspection, adjustment, anchor bolt torque checks, lubrication, calibration, cleaning, replacement of filters, and the like.
      2) Recommended schedule for each routine and preventive maintenance task.
      3) Lubricants:
         a) Provide lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
         b) Table of alternative lubricants.
5. Major Maintenance:
   a. Include detailed, written instructions and illustrations for required periodic (non-routine, non-preventative) maintenance.
   b. Indicate relative level of training and expertise required to perform such maintenance and recommended tools and equipment.
6. Special Maintenance:
   a. Include maintenance instructions for long-term shutdowns and storage.

E. Bills of Materials:
1. Include in operation and maintenance manuals complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
2. Manufacturer's name, physical address, telephone number, internet website address.
3. Manufacturer's local service representative's or local parts supplier's name, physical address, telephone number, internet website address, and e-mail addresses.
4. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
5. For each part or piece include the following information:
   a. Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
   b. Part name or description.
   c. Manufacturer's part number.
   d. Quantity of each part used in each assembly.

e. Current unit price of the part at the time the operation and maintenance manual is submitted. Price list shall be dated.

F. Record Copy of Shop Drawings, Product data, and Other Previously Approved and Accepted Submittals:

1. Submit original-quality copies of each approved and accepted (as applicable) Shop Drawing, product data Submittal, written results of source quality control activities, and other Submittals, updated to indicate as-installed condition. Do not include prior Submittals that were not approved or were not accepted. Reduced drawings are acceptable only when reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.

G. Electrical Schematics, Diagrams, and Information:

1. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
2. Include as-constructed drawings of layouts of electrical panels (such as switchgear and motor control centers) and control panels.

H. NFPA 70 (National Electric Code) Documentation:

1. Include in operation and maintenance manuals for electrically-powered equipment documented calculations of: (1) arc-fault current, equipment available fault current and (2) short-circuit current rating (SCCR), provided as part of equipment Submittals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ATTACHMENTS

A. The following, bound after this Section's "End of Section" designation, are part of this Section:

1. Attachment 1 - Equipment Data and Spare Parts Summary form (one page)
2. Attachment 2 - Recommended Maintenance Summary form (one page)
3. Attachment 3 - Lubrication Summary form (one page)

END OF SECTION

ATTACHMENT 1

Equipment Record

Equipment Data and Spare Parts Summary

Project Name	Specification Section:
Equipment Name	Year Installed:
Project Equipment Tag No(s).	
Equipment Manufacturer	Project/ Order No.
Address	Phone
Website / Web Site	E-mail
Local Representative/Service Center	
Address	Phone
Website	E-mail

MECHANICAL NAMEPLATE DATA

Equip.		Serial No.		
Make		Model No.		
ID No.	Frame No.	HP	RPM	Cap.
Size	TDH	Imp. Size	CFM	PSI
Other:				

ELECTRICAL NAMEPLATE DATA

Equip.				Serial No.				
Make				Model No.				
ID No.	Frame No.	HP	V.	Amp.	Hertz	PH	RPM	SF
Duty	Code	Ins. Cl.	Type	NEMA	C Amb.	Temp. Rise	Rating	
Other:								

SPARE PARTS PROVIDED PER CONTRACT

Part No.	Part Name	Quantity

RECOMMENDED SPARE PARTS

Part No.	Part Name	Quantity

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ATTACHMENT 2

Equipment Record

Recommended Maintenance Summary

Equipment Description	Project Equip. Tag No(s).	

RECOMMENDED BREAK-IN MAINTENANCE (FIRST OIL CHANGES, ETC.)	INITIAL COMPLETION * FOLLOWING START-UP							
	D	W	M	Q	S	A	RT	Hours

RECOMMENDED PREVENTIVE MAINTENANCE	PM TASK INTERVAL *							
	D	W	M	Q	S	A	RT	Hours

*** D = Daily W = Weekly M = Monthly Q = Quarterly S = Semiannual A = Annual Hours = Run Time Interval**

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ATTACHMENT 3

Equipment Record

Lubrication Summary

Equipment Description	Project Equip. Tag No(s).

Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					
Lubricant Point						
Lubricant Type		Manufacturer	Product	AGMA #	SAE #	ISO
	1					
	2					
	3					
	4					
	5					

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SECTION 01 78 36
WARRANTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for warranties required in the various Specifications.
2. Provisions addressing:
   a. Suppliers' standard warranties.
   b. Suppliers' special or extended warranties.
   c. Implied warranties.
   d. Commencement and duration of warranties.

1.2 SUBMITTALS

A. General:

1. For each item of equipment furnished under the Contract, submit Supplier's standard warranty, regardless of whether such warranty or Submittal thereof is required by the associated Specifications for that item. Submit such warranties for materials where such Submittal is required in the Specifications for the material.
2. For each item of material or equipment where Supplier's special (or extended) warranty is required by the Contract Documents, submit appropriate special warranty that complies with the Contract Documents.
3. Supplier's warranties shall be specifically endorsed to Owner, Contractor, and the entity purchasing the item (if other than Contractor) by the entity issuing such warranty.
4. Submit Suppliers' standard warranties and special warranties as Submittals in accordance with the Schedule of Submittals accepted by Engineer.

1.3 CONTRACTOR'S GENERAL WARRANTY AND CORRECTION PERIOD OBLIGATIONS

A. Contractor's General Warranty and Guarantee: Comply with requirements of the General Conditions, as may be modified by the Supplementary Conditions.

B. Contractor's Warranty of Title: Comply with requirements of the General Conditions, as may be modified by the Supplementary Conditions.

C. Correction Period: Comply with requirements of the General Conditions, as may be modified by the Supplementary Conditions.

1.4 SUPPLIERS' WARRANTIES FOR MATERIALS AND EQUIPMENT

A. Warranty Types:

1. Required by the General Conditions:
   a. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, Contractor's general warranty and guarantee and requirements for the Contract's correction period.
   b. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor's general warranty and guarantee, nor does such affect or limit Contractor's performance obligations under the correction period.
2. Material or equipment manufacturer's standard warranty is pre-printed, written warranty published by item's manufacturer and specifically endorsed by manufacturer to the entities indicated in this Specifications Section's Article 1.2.
3. Special warranty is written warranty that either extends the duration of material or equipment manufacturer's standard warranty or provides other, increased rights to Owner

and other beneficiaries (if any) of such warranty. Where the Contract Documents indicate specific requirements for warranties that differ from the manufacturer's standard warranty for that item, special warranty is implied.

B. Requirements for Special Warranties:

1. Submit written special warranty document that contains appropriate provisions and identification, ready for signature by material or equipment manufacturer, Owner, and other beneficiaries indicated in Article 1.2 of this Specifications Section. Submit draft warranty with Submittals required prior to fabrication and shipment of the item from the Supplier's facility.
2. Manufacturer's Standard Form: Modified to include Project-specific information and properly signed by product manufacturer and other entities as appropriate.
3. Specified Form: When specified forms for special warranties are included in the Contract Documents, prepare written document, properly signed by item manufacturer, Owner, and other beneficiaries indicated in Article 1.2 of this Specifications Section, using the required form.
4. Refer to the Specifications for content and requirements for submitting special warranties.

1.5 IMPLIED WARRANTIES

A. Warranty of Title and Intellectual Property Rights:

1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
2. Provisions on intellectual property rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Warranty of Merchantability:

1. Notwithstanding any other provision of the Contract to the contrary, implied warranties of merchantability required by Laws and Regulations apply to the materials and equipment incorporated into the Work.

C. Warranty of Fitness-for-Purpose:

1. Implied warranty of fitness-for-purpose for materials and equipment to be incorporated into the Work, for which specific material or features are indicated in the Contract Documents, is hereby disclaimed by Owner and Contractor.
2. When Supplier is aware of, or has reason to be aware of, specified materials or features of the Work that are contrary to the intended use, purpose, service, application, or environment in which the material or item will be used, submit request for interpretation. Where appropriate, such request for interpretation shall indicate the apparent discrepancy and propose appropriate, alternative materials or equipment.

1.6 COMMENCEMENT AND DURATION OF WARRANTIES

A. Commencement of Warranties:

1. Contract correction period and Contractor's general warranty commence as indicated in the General Conditions, as may be modified by the Supplementary Conditions.
2. Suppliers' standard warranties and special warranties commence running on the date that the associated item is certified by Engineer as substantially complete in accordance with the Contract Documents. In no event shall special warranties commence running prior to Engineer's review and acceptance of special warranty Submittal for the item.
3. Implied warranties commence in accordance with Laws and Regulations.

B. Duration of Warranties:

1. Duration of correction period is set forth in the General Conditions, as may be modified by the Supplementary Conditions.

2. Duration of Contractor's general warranty and guarantee is in accordance with Laws and Regulations.
3. Duration of Suppliers' standard warranties is in accordance with the applicable standard warranty document accepted for the Project by Engineer.
4. Duration of required Suppliers' special warranties shall be in accordance with the requirements of the Contract Documents for the subject item.
5. Duration of implied warranties shall be in accordance with Laws and Regulations.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Project record documents, to supplement record documents requirements of the General Conditions, as may be modified by the Supplementary Conditions.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, and services to establish, maintain, continuously update, and submit to Engineer Project record documents in accordance with the Contract Documents.

C. Related Sections include but are not necessarily limited to:

1. Section 01 29 73 - Schedule of Values.
2. Section 01 29 76 - Progress Payment Procedures.
3. Section 01 31 26 - Electronic Communication Protocols.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Obtain necessary field measurements and record all data required for Project record documents before covering up the Work or building on subsequent phases of the Work.
2. Promptly after obtaining measurements and information, record the data and information on Project record documents.
3. Where a licensed, registered professional land surveyor is retained on the Project, whether by Contractor or others, to perform field measurements and record other data for as-constructed Project or Site conditions, coordinate with such entity and schedule and perform the Work accordingly. Allow surveyor sufficient time and proper conditions for performing surveyor's work. Assist the surveyor as necessary in performance of surveyor's responsibilities.

B. Monthly Status Evaluation:

1. Not less than once per month, as a condition precedent to submitting Application for Payment, Contractor's site superintendent will meet with either Engineer or Resident Project Representative (RPR) at the Site to review status of Contractor's Project record documents.
2. When Engineer or RPR directs corrections to Project record documents, promptly make such corrections on the Project record documents. Engineer's or RPR's directions or lack thereof do not in any way relieve or mitigate Contractor's sole responsibility for the accuracy, completeness, and clarity of Project record documents.
3. Requirements for review of record documents status as a condition precedent to progress payments is in Section 01 29 73 - Schedule of Values, and Section 01 29 76 - Progress Payment Procedures.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Recorder of Changes and Field Conditions on Project Record Documents:
   a. Contractor's staff at the Site shall include not less than one person with suitable training and drafting (drawing) experience to record on the Project record documents changes made and field conditions encountered.

b. Recorder of changes and field conditions on the Project record documents shall possess not less than two semesters of drafting (drawing) training in a classroom, either in high school, college, or bona-fide vocational school.

c. Upon Engineer's request, submit name of proposed recorder at the Site, resume', or list of relevant experience, and copy of credentials of completion of such drafting (drawing) course(s).

d. If original recorder of changes and field conditions is replaced, promptly advise Engineer and RPR in writing and submit to Engineer qualifications of proposed replacement.

B. Samples of Similar Prior Work:

1. Submit Samples of the personal work of Contractor's designated recorder of changes and field conditions on the Project record documents from not less than two prior projects of similar type(s) of work at the Work. Submit copies of not less than two marked-up drawings from each prior project and copies of two pages of marked-up specifications from each prior project.

2. Samples shall be in the same form as proposed for the Project record documents. For example, where Contractor intends to submit hand-drawn mark-ups of the Drawings and Specifications, Samples shall be copies of hand-drawn markups. Where Contractor intends to submit Project record documents in native (executable) file format (such as CAD files), Samples shall be developed using the same software to be used in preparing the Project record documents.

3. If original recorder of changes and field conditions is replaced by Contractor, replacement recorder shall provide the same standard of work on Project record documents as indicated in the approved Samples.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Samples:

a. Sample of field-recorded project record documents from prior projects, in accordance with this Specifications section's "Quality Assurance" Article, to establish quality and style for markups of Project record documents. Submit within 15 days of the date the Contract Times commence running.

B. Informational Submittals: Submit the following:

1. Qualifications Statements:

a. When requested by Engineer, submit qualifications of proposed recorder of changes and field conditions for Project record documents at Contractor's field office at the Site. Qualifications shall comply with the "Quality Assurance" Article of this Specifications section.

C. Closeout Submittals: Submit the following:

1. Record Documentation:

a. Prior to readiness for final payment, submit to Engineer one copy of Project's final record documents and obtain Engineer's acceptance of same. Submit complete record documents; do not make partial Submittals without Engineer's concurrence.

b. Submit the following Project record documents:

1) Record Drawings, including those issued via Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

2) Record project manual, including Specifications, indicating changes made via Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

c. Submit record documents with transmittal letter on Contractor's letterhead in accordance with requirements in Section 01 33 00 - Submittal Procedures.

2. Certifications:
   a. Record documents Submittal shall include certification, with original signature of official authorized to sign legally-binding contracts on behalf of Contractor, reading as follows:
      1) (Contractor's legal/contractual entity name) has maintained, continuously updated, and submitted Project record documentation in accordance with the General Conditions and Supplementary Conditions, Section 01 78 39 - Project Record Documents, and other elements of Contract Documents, for the U.S. Department of the Interior, Bureau of Indian Affairs, Fort Hall Irrigation Project, Power County, Idaho, Bannock Pumping Plant Modernization. We certify that each record document submitted is complete, accurate, and legible relative to the Work performed under our Contract, and that the record documents comply with the requirements of the Contract Documents.

         By: (_____) (signature)
         Print Name: (_____)
         Title:)

1.5 MAINTENANCE OF RECORD DOCUMENTS

A. Maintain in Contractor's field office, in clean, dry, legible condition, complete sets of the following record documents:
   1. Drawings, Specifications, and Addenda;
   2. Shop Drawings, Samples, and other Submittals, including records of test results, approved or accepted as applicable, by Engineer;
   3. Change Orders, Work Change Directives, Field Orders, allowance authorizations;
   4. copies of all interpretations and clarifications issued;
   5. photographic documentation;
   6. survey data; and
   7. all other documents pertinent to the Work.

B. Provide files and racks for proper storage and easy access to Project record documents. File record documents in accordance with the edition of the Construction Specification Institute's *MasterFormat* used for organizing the project manual, unless otherwise accepted by Engineer or RPR.

C. Promptly make Project record documents available for observation and review upon request of Engineer, RPR, or Owner.

D. Do not use Project record documents for any purpose other than serving as Project record. Do not remove Project record documents from Contractor's field office without Engineer's approval.

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

A. Recording Changes, Field Conditions, and Other Information – General:
   1. At the start of the Project, label each record document to be submitted as, "PROJECT RECORD" using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.
   2. Keep record documents current consistent with the progress of the Work. Make entries on record documents within two working days of receipt of information required to record the change, field condition, or other pertinent information.
   3. Do not permanently conceal the Work until required information has been recorded for Project record documents.
   4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from Engineer-accepted Project record documents.
   5. Marking of Entries:

a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to Project record documents.
b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files in “portable document format” (.PDF) files.
c. Date each entry on record documents.
d. Indicate changes by drawing a “cloud” around the change(s) indicated.
e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

B. Drawings:
1. Record changes on copy of the Drawings. Submittal of Contractor-originated or -produced drawings as a substitute for recording changes on a copy of the Drawings is unacceptable.
2. Record changes on plans, sections, elevations, schematics, schedules, and details as required for clarity, accuracy, and completeness, making reference dimensions and elevations (to Project datum) for complete record documentation.
3. Record actual construction including:
a. Depths of various elements of foundation relative to Project datum.
b. Horizontal and vertical location of Underground Facilities referenced to permanent surface improvements and Project elevation datum. For each Underground Facility, including pipe fittings, show and indicate dimensions to not less than two permanent, visible surface improvements.
c. Location of exposed utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure and, where applicable, to Project elevation datum.
d. Changes in structural and architectural elements of the Work, including changes in reinforcing.
e. Field changes of dimensions, arrangements, and details.
f. Changes made in accordance with Addenda, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.
g. Changes in details on the Drawings. Submit additional details prepared by Contractor when required to document such changes.
4. Recording Changes for Schematic Layouts:
a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by Contractor subject to acceptance by Engineer.
b. Record on the Project record documents all revisions to schematics on the Drawings, including: piping schematics, ducting schematics, process and instrumentation diagrams, control and circuitry diagrams, electrical one-line diagrams, motor control center layouts, and other schematics when included in the Drawings. Show and indicate actual locations of equipment, lighting fixtures, in-place grounding system, and other pertinent data.
c. When dimensioned plans and dimensioned sections or elevations on the Drawings show the Work schematically, indicate on the Project record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as conduit, piping, ducts, and similar items
1) Clearly identify each item of the Work by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.
2) Show by symbol or by note the vertical location of each item of the Work; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and

similar designations. For piping not embedded, also indicate elevation dimension relative to Project elevation datum.

3) Descriptions shall be sufficiently detailed to be related to the Specifications.

d. Engineer may furnish written waiver of requirements relative to schematic layouts shown on plans, sections, and elevations when, in Engineer's judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on such waiver(s) being issued.

5. Supplemental Drawings:

a. In some cases, drawings produced during construction by Engineer or Contractor supplement the Drawings and shall be included with Project record documents submitted by Contractor. Supplemental record drawings shall include drawings or sketches that are part of Change Orders, Work Change Directives, Field Orders, and allowance authorizations and that cannot be incorporated into the Drawings because of space limitations.

b. Supplemental drawings submitted with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.

c. When supplemental drawings developed by Contractor using computer-aided drafting/design (CAD), building information models (BIM), or civil information models (CIM) software are to be included in record drawings, submit electronic files for such drawings in accordance with Section 01 31 26 – Electronic Communication Protocols, as part of record drawing Submittal. Label such files, "Supplemental Record Drawings", including with Contractor's name, Project name, and Contract designation.

d. When supplemental drawings developed by Contractor using computer-aided drafting/design (CAD), building information models (BIM), or civil information models (CIM) software are to be included in record drawings, submit electronic files for such drawings in Autodesk Revit and Autodesk Civil 3D, versions to be approved by the Engineer, as part of record drawing Submittal. Submit electronic files online through Microsoft OneDrive labeled, "Supplemental Record Drawings", including Contractor's name, Project name, and Contract designation.

C. Specifications and Addenda:

1. Mark each Specifications section to record:

a. Manufacturer, trade name, catalog number, and Supplier of each material and equipment item actually furnished.

b. Changes made by Addendum, Change Orders, Work Change Directives, Field Orders, and allowance authorizations.

1.7 ELECTRONIC DOCUMENTS FURNISHED BY ENGINEER

A. CAD, BIM, or CIM files of the Drawings will be furnished by Engineer upon the following conditions:

1. Contractor shall submit to Engineer a letter on Contractor letterhead requesting CAD, BIM, or CIM files of the Drawings and indicating specific definition(s) or description(s) of how such Electronic Documents will be used by Contractor, and specific description of benefits to Owner (including credit proposal, if applicable) if the request is granted.

2. Engineer does not guarantee that Electronic Documents are available in the format(s) requested by Contractor. Some projects may have Drawings developed using only CAD software instead of BIM or CIM software. Engineer will not create BIM or CIM files for Contractor if such files do not already exist.

3. Contractor shall sign Engineer's standard agreement with Contractor for for release of Electronic Documents and shall abide by the provisions of such agreement for release of Electronic Documents.

4. Layering system incorporated in CAD, BIM, and CIM files shall be maintained as transmitted by Engineer. CADD, BIM, and CIM files transmitted by Engineer containing

cross-referenced files shall not be bound by Contractor. Drawing cross-references and paths shall be maintained. If Contractor alters layers or cross-reference files, Contractor shall restore all layers and cross-references prior to submitting Project record documents to Engineer.

5. Contractor shall submit Project record drawings to Engineer in same CAD, BIM, or CIM format that files were furnished to Contractor.

B. Microsoft Word files of Specifications:

1. Requirements for Engineer's potential release of word processing files of the Specifications or other written documents in native format are the same as those for Drawings.
2. When Specifications are released in native format, Contractor shall submit record specifications in the same format, with all changes tracked using Microsoft Word's "track changes" feature.
3. Do not modify the formatting of the native files furnished by Engineer. If formatting changes are made without Engineer's authorization, remedy the formatting to the same condition and status as when the files were first delivered to Contractor. Such remedy shall be at Contractor's expense.
4. Comply with all requirements of this Specifications section regarding record specifications.
5. After delivery of record specifications Submittal to Engineer, delete from Contractor's files the native word processing files. Contractor may retain a PDF version of such files for Contractor's records.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 79 23

INSTRUCTION OF OPERATION AND MAINTENANCE PERSONNEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for instruction of operation and maintenance personnel.
2. Qualifications requirements for Suppliers' training personnel.
3. General requirements for training.
4. Schedule of required training sessions.

B. Scope:

1. Contractor shall furnish services of Suppliers' operation and maintenance training specialists to instruct Owner's and facility manager's personnel in recommended operating and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
2. Each Supplier shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.

   Owner or facility manager reserves the right to record training sessions on video for Owner's or facility manager's later use in instructing Owner's or facility manager's personnel.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Scheduling of Training Sessions:

1. General:
   a. Contractor shall coordinate training services with checkout, startup, and initial operation of materials and equipment on days and times, and in manner, acceptable to Owner and facility manager, in accordance with the Contract Documents.
   b. Training may be required outside of normal business hours to accommodate schedules of operation and maintenance personnel. Provide training services at the required days and times at no additional cost to Owner.
2. Prerequisites to Training:
   a. Training of facility operation and maintenance personnel shall commence after preliminary operation and maintenance data has been submitted and accepted by Engineer, and the Work required in Section 01 75 00, Checkout and Startup Procedures, is complete.
   b. At option of Owner, facility manager, or Engineer, training may be allowed to take place before, during, or after checkout and startup of materials and equipment.
3. Training Schedule Submittal:
   a. Training Schedule Required: Contractor shall prepare and submit proposed training schedule for review and acceptance by Engineer, facility manager, and Owner. Proposed training schedule shall show and indicate all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training for various elements of the Work, number of training sessions, and scheduling.
   b. Training Schedule Coordination: When Project has multiple prime contracts, prime Contractors shall comply with this Specifications section. All prime Contractors shall coordinate with the General Contractor in developing a single training schedule Submittal for the entire Project, to be submitted by General Contractor. All prime Contractors shall implement training in accordance with the approved training schedule.

c. Timing of Training Schedule Submittal: Submit initial training schedule not less than 60 days before scheduled start of first training session. Submit final training schedule, incorporating revisions in accordance with Engineer's comments, not later than 30 days prior to starting the first training session.

d. Owner or facility manager reserves the right to modify personnel availability for training in accordance with process or emergency needs at the facility.

B. Training Scheduling Conference:

1. Prior to preparing initial training schedule Submittal, schedule and hold training scheduling conference at the location where progress meetings are held, to review:
   a. Training requirements indicated in the Contract Documents.
   b. Work to be completed prior to commencing training.
   c. Work progress and Progress Schedule relative to startup and training.
   d. Scheduling constraints for Owner's and facility manager's personnel, relative to days and times of training sessions.
   e. Preferred days for training.
   f. Location where training will be performed and facilities available.
   g. Required Submittals relative to training.
   h. Other issues relative to training of operation and maintenance personnel.
2. Attendance is mandatory for the following:
   a. Contractor's project manager.
   b. Contractor's Site superintendent.
   c. Project manager of Subcontractors responsible for furnishing materials and equipment for which training of operation and maintenance personnel is required.
   d. Suppliers invited by Contractor.
   e. Engineer.
   f. Resident Project Representative (RPR).
   g. Owner's Site Representative (OSR).
   h. Facility manager's staff responsible for training coordination, and staff responsible for scheduling operation and maintenance personnel.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.
4. Contractor shall prepare minutes summarizing the discussions of conference, decisions made, and agreements and disagreements, and distribute the minutes to each conference attendee and others as appropriate.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Supplier's Instructors:
   a. Shall be factory-trained by manufacturer of material or equipment.
   b. Supplier's instructors shall be proficient and experienced in performing training of the types required.
   c. Instructors shall be proficient, clear, and easily understandable in spoken and written English language.
   d. Qualifications of instructors are subject to acceptance by Engineer. If Engineer does not accept qualifications of proposed instructor, provide services of replacement instructor with acceptable qualifications.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule Submittals in accordance with time frames specified in this Specifications section.

B. Informational Submittals: Submit the following:

1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table 01 79 23-A and the Contract Documents. Lesson plan shall comply with requirements of this Specifications section as may be supplemented by Specifications sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during training sessions. Submit lesson plan Submittals in accordance with time frames specified in this Specifications section.
2. Qualifications:
   a. Credentials of Supplier's proposed operation and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Specifications section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.
3. Minutes of training scheduling conference.

C. Closeout Submittals: Submit the following:

1. Trainee sign-in sheets for each training session. Submit to facility manager's training coordinator with copy to Engineer.

1.5 LESSON PLAN

A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be provided, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.

B. Submit acceptable lesson plan not less than 21 days prior to starting associated training.

C. Indicate in lesson plan estimated duration of each training segment.

D. Lesson plan shall include the following:

1. Material and Equipment Overview (required for all types of operation and maintenance training):
   a. Describe material and equipment's operating (process) function and performance objectives.
   b. Describe material and equipment's fundamental operating principles and dynamics.
   c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
   d. Identify all support materials and equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
   e. Identify and describe safety precautions and potential hazards related to operation.
   f. Identify and describe in detail safety and control interlocks.
2. Operations Personnel Training:
   a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
   b. Operation:
      1) Describe operating principles and practices.
      2) Describe routine operating, startup, and shutdown procedures.

3) Describe abnormal or emergency startup, operating, and shutdown procedures that may apply.
4) Describe alarm conditions and responses to alarms.
5) Describe routine monitoring and recordkeeping procedures.
6) Describe recommended housekeeping procedures.

c. Troubleshooting:
1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.

3. Mechanical Maintenance Training:
a. Material and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
b. Material and Equipment Preventive Maintenance:
1) Describe preventative maintenance inspection procedures required to:
a) Inspect materials and equipment in operation.
b) Identify potential trouble symptoms and anticipate breakdowns.
c) Forecast maintenance requirements (predictive maintenance).
2) Define recommended preventative maintenance intervals for each component.
3) Describe lubricant and replacement part recommendations and limitations.
4) Describe appropriate cleaning practices and recommend intervals.
5) Identify and describe use of special tools required for maintenance of materials and equipment.
6) Describe component removal, installation, and disassembly and assembly procedures.
7) Perform “hands-on” demonstrations of preventive maintenance procedures.
8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
9) Define recommended torqueing, mounting, calibrating, and aligning procedures, tolerances, and settings, as appropriate.
10) Describe recommended procedures to check and test equipment following corrective maintenance.
c. Troubleshooting:
1) Define recommended systematic troubleshooting procedures.
2) Provide component-specific troubleshooting checklists.
3) Describe applicable materials and equipment testing and diagnostic procedures to facilitate troubleshooting.
4) Describe common corrective maintenance procedures with “hands-on” demonstrations.

4. Instrumentation/Controls and Electrical Maintenance Training:
a. Materials and Equipment Overview: As described in Paragraph 1.5.D.1 of this Specifications section.
b. Preventative Maintenance and Troubleshooting of Instrumentation and Control Systems: Engineer may grant waiver(s) to allow all training for a given system to be at the location of Owner’s training facility.
c. Preventative Maintenance and Troubleshooting of Other Electrical Systems: In accordance with requirements for Paragraph 1.5.D.3 of this Specifications section.

1.6 TRAINING AIDS

A. Supplier’s instructor(s) shall incorporate training aids as appropriate to assist in the instruction. Provide handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:

1. Audio-visual aids, such as videos, Microsoft PowerPoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.
2. Equipment cutaways and samples, such as spare parts and damaged equipment.
3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.

B. Handouts:

1. Supplier's instructor(s) shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.
2. Photocopied handouts shall be good quality and completely legible.
3. Handouts shall be coordinated with the instruction, with frequent references made to the handouts.
4. Provide not less than 10 paper copies of each handout for each training session.

C. Audio-Visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. Audio-visual equipment that training provider shall provide, as required, includes:

1. Laptop computer, presentation software, and suitable projector.
2. Power cords, power strips/surge protectors.
3. As required, extension cords, HDMI cables and other video cabling, and spare bulb for projector.
4. Laser pointer/slideshow remote controller with extra batteries..

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TRAINING DELIVERY

A. Training Delivery – General:

1. Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear, and proceed according to lesson plan accepted by Engineer, with lesson content appropriate for trainees. If Owner or Engineer deems that training delivery does not comply with the Contract Documents, training shall be postponed, rescheduled, and re-performed in acceptable manner at no additional cost to Owner and facility manager.
2. Trainee Sign-in Sheets: In format acceptable to Owner, furnish sign-in sheet for trainees for each session. Sign-in sheets shall include the Project name; materials, equipment, or system for which training was provided; and type of training (e.g., operations, mechanical maintenance, instrumentation/controls and electrical maintenance, or other), and full name and operator license number (when applicable) of each trainee. Upon completion of training, submit copy of each sign-in sheet as indicated in Article 1.4 of this Specifications section.

B. "Hands-on" Demonstrations:

1. Supplier's instructor(s) shall present "hands-on" demonstrations of operation and maintenance of materials and equipment for each training session, in accordance with lesson plan accepted by Engineer.
2. Contractor and manufacturer shall furnish tools necessary for demonstrations.

3.2 SCHEDULE OF REQUIRED TRAINING

A. Supplier shall provide not less than the hours of training and number of sessions indicated in Table 01 79 23-A of this Specifications Section. Travel time and expenses are responsibility of Supplier and are excluded from required training time indicated in the Contract Documents.

B. Shifts and Training Sessions Required:

1. Training Sessions per Shift:

a. Operators: Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days. Provide identical training sessions as follows:
   1) Two identical sessions during day shift, each session in a different week.
   2) One session during evening shift.
   3) One session during night shift.
b. Mechanical Maintenance: Provide two identical training sessions during day shift, each session in a separate week, for indicated materials and equipment. Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days.
c. Instrument/Controls and Electrical Maintenance: Provide two identical training sessions during day shift, each session in a separate week, for indicated equipment. Maximum training per day is four hours; sessions longer than four hours will be spread over multiple, preferably consecutive, days.

TABLE 01 79 23-A, TRAINING SUMMARY TABLE

Material or Equipment	Specification Section	Total Training Time (hours)	Training Sessions Required		
			Operations	Mechanic Maint.	Instrument/ Controls & Electrical Maint.
General – Pump Oil-Lube System	43 24 05	4	2	2	
General – Vertically Suspended Centrifugal Pumps	43 24 05	12	2	2	
General – Compressed Air System	22 15 00	8	2	2	
Process – Control Screens	40 61 96	24	3		3
Process – Flow Instrumentation	40 71 00	4	2		2
Process – Level Instrumentation	40 72 00	4	2		2
Process – Pressure Instrumentation	40 73 00	4	2		2
Process – Check Valves	40 05 66	4	2	2	
Process – Butterfly Valves	40 05 64	4	2	2	
Process - Flowmeters	40 71 00	4	2	2	
Process – Actuators for Valves and Gates	40 05 57	4	2	2	
General – Inline Canal Traveling Screen	46 21 12	14	2	2	
General – Overhead Bridge Crane	41 22 13	12	2	2	
HVAC – Electric Room Control Room HVAC Equipment	23 80 00	4	2	2	
HVAC – Instrumentation & Control	23 09 00	4	2		2
Electrical Distribution System – Locations/Controls	26 20 00	4	2		2
Electrical – Variable Frequency Drives	26 29 23	8	2		2
Electrical – Motor Control Equipment	26 24 19	4	2		2

Electrical – Propane Generator	26 32 15	12	2	2	2
Electrical – Low-Voltage Motor Control Centers	26 24 19	4	2		2
Contract Total		**142**			

END OF SECTION

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SECTION 01 81 10
WIND AND SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The following types of design criteria for the Project, including Work designed by (a) Engineer and (b) delegated design professional(s) retained by Contractor, Subcontractor, or Supplier and submitted for Engineer's approval under the Contract:
   a. Wind loading.
   b. Seismic.
   c. Snow loading.

B. Scope:

1. Certain Work, expressly indicated, shall be designed, fabricated, and installed in accordance with the wind , snow, and seismic requirements of this Section and Laws and Regulations (including applicable building codes).
2. This Section applies to all the Work. Where wind , snow, and seismic design criteria indicated in this Section conflict with wind , snow, and seismic design criteria set forth elsewhere in the Contract Documents, the more-stringent loading and requirements shall govern, unless clarified in writing by Engineer. Obtain Engineer's written interpretation or clarification of conflicts prior to performing the subject design and other associated Work.
3. Contractor shall provide all labor, materials, equipment, tools, professional services, and incidentals to provide wind , snow, and seismic design for the Work.
4. Such Work includes, but is not necessarily limited to, the following:
   a. Anchorage of mechanical and electrical equipment and systems.
   b. Anchorage of supports for piping, electrical conduits and cable trays, and similar Work.
   c. Work requiring delegated professional design for the final, completed Project.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 01 35 73 - Delegated Design Procedures.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate all wind , snow, and seismic design required of Contractor for the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Civil Engineers / Structural Engineering Institute (ASCE/SEI):
   a. 7-22, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
2. When referenced standards conflict, the most-stringent governs, unless specifically indicated otherwise in the Contract Documents or unless approved otherwise in writing by the Engineer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following as part of the Submittals required in Divisions 02-49 Specifications that require wind , snow, and seismic delegated designs:

1. Delegated Design Professional's "Instruments of Service" Submittals:

a. Delegated design professional's "certification of compliance" required by Section 01 35 73 - Delegated Design Procedures, regarding structural calculations:
   1) Indicate compliance with performance and design criteria indicated in the Contract Documents.
   2) Indicate compliance with specific reference standards indicated in the building code and the associated Contract Documents.
   3) Indicate other information required for "certification of compliance" in accordance with Section 01 35 73 - Delegated Design Procedures.

B. Informational Submittals: Submit the following as part of the Submittals required in Divisions 02-49 Specifications that require wind , snow, and seismic delegated designs:
   1. Delegated Design Professional's Calculations:
      a. Such calculations shall include delegated design professional's seal, signature, and date and are to indicate the following, which will not be reviewed by Engineer except for the limited purposes indicated in Section 01 35 73 - Delegated Design Procedures:
         1) Indicate basis of design and lateral analysis as necessary and required to derive each loading and to indicate system stability, including compatibility of deflections and compatibility with allowable soil parameters, as applicable.
         2) Indicate design load to each connection to structure (where connection will attach to or interface with, or supported by, elements designed by Engineer).
         3) Indicate and provide complete lateral load resisting system that transfers all wind and seismic loads through load path to ground.
   2. Shop Drawings and Product Data Approved by Delegated Design Professional: The following are required but will be reviewed by Engineer only for the limited purposes indicated in Section 01 35 73 - Delegated Design Procedures:
      a. Shop Drawings showing and indicating proposed wind , snow, and seismic controls Work designed by delegated design professional.
      b. Product data showing and indicating proposed wind , snow, and seismic controls Work designed by delegated design professional.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN CRITERIA FOR WIND ,SNOW, AND SEISMIC

A. This Article 2.1 applies to wind , snow, and seismic design criteria.

B. Design by delegated design professional retained by Contractor, Subcontractor, or Supplier shall comply with:
   1. Performance and design criteria indicated in the applicable Contract Documents, including this Section.
   2. Laws and Regulations, including applicable building code.
   3. Applicable reference standards indicated in the Contract Documents.

C. Risk Category: II.
   1. Design in accordance with building code load combinations for, at Contractor's option, either service level or factored level.
   2. Mechanical and electrical equipment and systems loads are dead loads, except where mechanical elements, such as piping and tanks, are filled with material such as liquid or slurry (in which case the dead load of the pipe's or vessel's contents shall also be included).

2.2 WIND DESIGN CRITERIA

A. Wind Design Load Criteria:
   1. Basic Wind Speed: V_{ult} = 104miles per hour.
   2. Exposure Category: C.

3. Topographic Factor: K_{zt} = 1.0.
4. Wind Importance Factor: I_w = 1.00.
5. Building description for wind design is Enclo sed.

B. Wind forces must be resisted by direct load transfer through fasteners to wind-resisting elements. Do not use connections that employ friction to transfer wind forces.

2.3 SEISMIC DESIGN CRITERIA

A. Seismic Design Load Criteria:

1. Design spectral acceleration at short period: S_{DS} = 0.40.
2. Design spectral acceleration at 1-second period: S_{D1} = 0.23.
3. Importance Factor: Ie = 1.0.
4. Seismic Design Category: B.
5. Component resonance ductility factor, ($R\mu$) and component strength factor (R_{Po}): In accordance with ASCE 7-22, Tables 13.5-1 and 13.6-1.
6. Component Importance Factor:
   a. All Components: I_P = 1.00.

B. Seismic forces must be resisted by direct load transfer through fasteners to seismic-resisting elements. Do not use connections that employ friction to transfer seismic forces.

2.4 SNOW DESIGN CRITERIA

A. Snow Design Load Criteria:

1. Design ground snow load: p_g = 37 psf
2. Design exposure factor: C_e = 0.9
3. Design slope factor: C_s = 1.0
4. Design thermal factor: C_t = 1.2
5. Minimum snow load for low-slope roofs: p_m 25 psf
6. Minimum flat roof snow load: p_f = 28 psf
7. Design considerations for partial loading, unbalanced snow, snow drift in the vicinity of adjacent structures or projections, sliding snow, and other applicable factors shall be considered at locations required by Laws and Regulations, including applicable building codes.
8. In no event shall snow design load criteria or minimum snow load be less than required by authority having jurisdiction.

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 81 33
CYBER SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. General requirements for cyber security measures applicable to all the Work.
2. Requirements to furnish to Owner copy of code and configuration files, passwords, physical keys for monitoring and control systems in accordance with the Contract Times and other requirements of the Contract Documents.
3. General requirements for microprocessor-based equipment.

B. Scope:

1. This Section indicates cyber security requirements applicable to all equipment, controls, devices, and other items furnished to Owner and Owner-furnished items modified as part of the Work, containing microprocessor-based systems and that will be (as part of the Work) or can be (in the future, not as part of the Project) connected to Owner's network or the Internet. Such items include but are not limited to the following: programmable logic controllers (PLC), programmable automation controllers (PAC), remote terminal units (RTU), distributed control units (DCU), direct digital controls (DDC), operator interface terminals (OIT), network equipment, configurable microprocessors, and human-machine interfaces (HMI).
2. This Section applies regardless of whether the subject items were furnished or modified by Contractor, Subcontractor, or Supplier of any tier.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 31 26 - Electronic Communication Protocols.
2. Section 40 61 13 – Process Control System General
3. Section 40 61 93 – Process Control System Input-Output List
4. Section 40 63 43 – Programmable Logic Controllers
5. Section 40 66 40 – Telemetry Systems
6. Section 40 67 00 – Control System Panels and Racks

1.2 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
   a. "Code and configuration files" mean any and all code or equipment configuration backup files, whether created by or for Contractor, Supplier, or Subcontractor, needed for Owner or facility manager to restore equipment and systems to final condition of equipment and systems prevailing at the time of readiness for final payment. Code and configuration files do not include original equipment manufacturer (OEM) software's underlying proprietary code such as firmware or operating system code. For example, for variable frequency drives (VFD), the configuration file of parameters of each individual VFD furnished or modified under the Project is required. However, the OEM's source code that runs the VFD firmware need not be furnished to Owner or facility manager.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Submit the following after obtaining Engineer's approval of Shop Drawings and product data Submittals for such devices under other Divisions of the Specifications.
    a. Preliminary Internet Protocol (IP) Network-Capable Device Asset Inventory:
        1) Notwithstanding the requirements of Section 01 31 26 - Electronic Communication Protocols, submit in native (executable) Microsoft Excel spreadsheet format.
        2) Include networked components furnished as part of the Work or modified as part of the Work.
        3) Submit in accordance with the Requirements of Section 01 31 26 - Electronic Communication Protocols.
        4) Submittal shall include the following for each device:
            a) Device identification designation.
            b) Manufacturer.
            c) Model number.
            d) Device use description.
    b. Network Diagrams:
        1) Notwithstanding the requirements of Section 01 31 26 - Electronic Communication Protocols, submit in native (executable) Autodesk Revit], [Autodesk AutoCAD],], file format, and the format required by Section 01 31 26 – Electronic Communication Protocols.
        2) Submit in accordance with the Requirements of Section 01 31 26 - Electronic Communication Protocols..
        3) Logical Network Diagram(s): Show information flow through network(s), and include:
            a) Major network devices, subnets, and virtual local area networks (VLAN).
            b) Include all wireless communication devices.
            c) Indicate the following information for each networked device:
                (1) Device identification designation.
                (2) Device description.
                (3) Manufacturer and model number.
                (4) MAC address.
                (5) IP address.
                (6) Ports and Protocols
        4) Physical Network Diagram(s): Show all physical network components, ports, protocols, connections, and cables. Show or indicate wireless communication devices including physical location.
        5) Draft code and configuration files for programmable or configurable devices, in accordance with this Section's "Code and Configuration Requirements" Article.

B. Close-out Submittals: Submit the following:
    1. Password Turnover: Furnish Submittal and obtain Owner's acceptance of the following not later than requesting inspection for Substantial Completion:
        a. Coordinate with Owner to securely transmit directly to Owner list of usernames and passwords applied to replace factory and Supplier's defaults.
    2. Final code and configuration files for programmable or configurable devices, in accordance with this Section's "Code and Configuration Requirements" Article.
    3. Record Documentation:
        a. As-Manufactured Network Diagrams: Provide promptly after factory acceptance testing and prior to delivery of factory-tested items to the Site. Include copies of record documentation Submittals accepted by Engineer in preliminary operation and maintenance manuals required.

b. As-Installed Network Diagrams: Provide promptly upon Substantial Completion. Include copies of record documentation Submittals accepted by Engineer in final operation and maintenance manuals required.

4. The Work will not be eligible for inspection for Substantial Completions until all Closeout Submittals required under this Section, are acceptable to Owner or Engineer, as applicable. If code and configuration files are modified for any reason following Substantial Completion, furnish revised code and configuration files prior to requesting inspection for final completion.

1.4 CODE AND CONFIGURATION REQUIREMENTS

A. Copies of Code and Configuration Files – General:

1. Submit as Electronic Documents only. Paper Submittals are not required for program code and configuration files.
2. Furnish directly to Owner via secure transmission method acceptable to Owner. Provide proof of file transfer for Submittal record purposes.
3. In accordance with the Contract Documents, promptly following Substantial Completion, Owner and facility manager, if any, shall have right to: (a) modify program code and configuration files, (b) update software and firmware, (c) revise system security settings, such as passwords, IP addresses, and other security settings, and (d) implement related modifications, without restriction or interference from Contractor, Subcontractor, Supplier, and others.
4. Owner and facility manager, if any, agree to use program code and configuration files only with Owner's facilities, as may be transferred to Owner's successors and assigns.
5. Owner and facility manager, if any, will not be subject to any Supplier-requested non-disclosure agreement that is not part of the Contract Documents.
6. Engineer will not distribute program code and configuration files obtained under the Project, except in exchanging such files with Owner, facility manager, or their successors and assigns. Engineer will not be party to any Supplier-requested non-disclosure agreement.
7. Submit only code prepared specifically for the Project, including facility-specific program code. Program code normally furnished by equipment manufacturers for operation of their own equipment and systems is exempt from this provision and need not be submitted.
8. Third-party, licensed, commercially available software (such as, but not limited to, Microsoft operating system software sold at retail, commercial SCADA system software platforms, and PLC programming software) is excluded from requirements of this Article. Furnish copies of commercially available, licensed, third-party software, where required, in accordance with the Contract Documents.
9. Contractor (including Subcontractors and Suppliers) is not responsible for configurations and control setpoints subsequently changed by Owner, facility manager, or others for whom either is responsible, when such changes were not in accordance with Supplier's written recommendations and operation and maintenance instructions.
10. Code, configurations and systems shall not be hidden or protected by encryption, passwords, or other means without furnishing such passwords or access to Owner's or facility manager's (if other than Owner), designated personnel.

B. Code and Configuration File Submittal Requirements:

1. For each software application configured for the Project, submit backup of files necessary for application restoration including but not limited to application files, configuration files, and settings and setpoints.
2. For each network component submit backup of files necessary for restoration of device including but not limited to device configuration files and software application backups for host-based devices.
3. For each microprocessor-based system, submit configuration and application backup files necessary for device restoration.

4. For each Operating System based computing asset, provide backup or image of the configured environment as required for system restoration.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND SYSTEMS

A. Controls:

1. Micro-processor based, computing and network equipment furnished shall be current and not be obsolete or subject to a manufacturer's end-of-life notice of less than two years after Substantial Completion.
2. Submit Suppliers' end-of-life notices, if any, for equipment as part of Shop Drawing or product data Submittal for the subject item.
3. Demands for non-disclosure agreements (NDAs) or other measures that would restrict or prevent Owner and facility manager (if other than Owner) from obtaining or using information, licenses, operational and performance data, and software are unacceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installing the Work constitutes Contractor's approval of conditions existing at the time the Work is performed, including, where applicable, existing code and configuration files that affect the Work associated with cyber-security procedures.

3.2 REMOTE ACCESS TO INSTALLED EQUIPMENT AND SYSTEMS

A. Requesting Remote Access - General:

1. Unless expressly indicated otherwise in the Contract Documents, remote access devices for interaction with programmable devices are unacceptable during construction or operation.
2. Where remote access is requested, furnish appropriate written request, to Owner, through Engineer, requesting access, indicating desired methods of access, reason for remote access (i.e., programming, view only data, emergency support, or other, specifically indicated reason).
3. Coordinate with Owner and facility manager, through Engineer, to identify acceptable access method, if any, consistent with Owner's and facility manager's, cyber-security risk tolerance.

3.3 CLOSEOUT ACTIVITIES

A. Promptly Upon Substantial Completion:

1. Update firmware of programmable devices to Supplier's current version.
2. Owner and facility manager (if other than Owner) shall receive full access and use of equipment and system monitoring and control capabilities, including: Code and configuration files.
3. In addition, upon Owner's issuance of payment to Contractor and Contractor's acceptance thereof for the equipment and systems, including code and configuration files:
   a. Ownership transfers to Owner upon Owner's payment (and Contractor's acceptance thereof) of 100percent of the value assigned the associated item in the Schedule of Values accepted by Engineer, minus retainage Owner is entitled to withhold under the Contract and minus other set-offs (expressly applicable to the subject equipment) under the Contract.
   b. Internal function blocks and code prepared specifically for the Project shall become Owner's property for exclusive use by Owner and facility manager (if other than Owner) at the Site. Such rights shall transfer to Owner's successors and assigns, if any, and if such equipment is relocated by Owner to a different site or facility, whether or not at the same address as the Site.

c. Owner has the right to modify, either via Owner's or facility manager's employees or by a third-party systems integrator retained by either Owner or facility manager, code and configuration files developed specifically for the Project, as well as hardware furnished as part of the Work.

d. Originator or developer of code and configuration files shall fully release claims to ownership of the intellectual property, trade secrets, or sensitive information for the furnished equipment and systems, as may be claimed by such entity.

4. Owner and facility manager (if other than Owner) shall have the right to modify, enhance or make changes to equipment as deemed necessary or desired by Owner, including hardware, software, networking settings, passwords or other information or settings that Owner or facility manager changes for maintenance, upgrade, or cybersecurity reasons. Owners or facility managers exercising such rights: (a) shall be in accordance with equipment manufacturer's written operation and maintenance data and shall not serve to void applicable warranties in effect; and (b) do not apply to modifications made by Owner or facility manager to Supplier's standard software code not prepared specifically for the Project.

B. Usernames and Passwords:

1. Change Supplier's default usernames and passwords in coordination with requirements of Owner's or facility manager's (as applicable) personnel.
2. Remove each username and password established or used by Contractor, Subcontractor, or Supplier prior to Substantial Completion of equipment or system.

C. Programmable Operator Interface Terminals (OIT) and Other Graphical Interface Terminals:

1. For equipment that supports multiple levels of security, configure the following security levels:
   a. View.
   b. Operate.
   c. Supervisor.
   d. Administrator.
2. For equipment that supports only view/operate levels of security, provide password protection and furnish directly to Owner or facility manager (as applicable) passwords necessary to operate functions.
3. Coordinate directly with Owner and facility manager passwords and furnish password turn-over Submittal required in this Section's "Submittals" Article.

END OF SECTION

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DIVISION 02

EXISTING CONDITIONS

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SECTION 02 26 00
HAZARDOUS MATERIALS ASSESSMENT

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. Section 01 57 20 – Environmental Protection

B. Section 02 41 00 – Demolition

1.2 HAZARDOUS MATERIALS ASSESSMENT

A. Owner has not conducted a limited survey for lead-based paint and asbestos-containing materials within the project area. The facility was constructed in 1965.

B. Asbestos-containing materials are assumed to be present within the existing pumping plant.

1. The asbestos National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61, Subpart M) regulates asbestos fiber emissions and asbestos waste disposal practices. The asbestos NESHAP regulation also requires the identification and classification of existing ACM according to friability prior to demolition or renovation activity. Friable ACM is a material containing more than 1% asbestos that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. All friable ACM is considered regulated asbestos containing material (RACM).
2. The asbestos NESHAP regulation classifies material subject to demolition or renovation as either RACM, Category I non-friable ACM, or Category II non-friable ACM. RACM includes all friable ACM (pre-disturbance), along with Category I non-friable ACM that becomes friable (during disturbance), and Category I non-friable ACM subject to sanding, grinding, cutting, or abrading, or Category II non-friable ACM with a high probability of becoming crumbled, pulverized, or reduced to powder by forces expected to act on the material during disturbance. Category I non-friable ACM are exclusively asbestos-containing packings, gaskets, resilient floor coverings, and asphalt roofing products that contain more than 1% asbestos. Category II non-friable ACM are all other non-friable materials (other than Category I non-friable ACM) that contain more than 1% asbestos. Category II non-friable ACM generally includes (but is not limited to) cementitious material such as cement pipes, cement siding, cement panels, glazing, mortar, and grouts.
3. The United States Occupational Safety and Health Administration (OSHA) asbestos standard for construction (29 CFR 1926.1101) regulates workplace exposure to asbestos. The OSHA standard requires that employee exposure to airborne asbestos must not exceed 0.1 fiber per cubic centimeter of air (0.1 f/cc) as an eight-hour time weighted average (TWA) and not exceed 1.0 fiber per cubic centimeter of air (1.0 f/cc) over a 30-minute time period known as an excursion limit (EL). The TWA and EL are known as OSHA's asbestos permissible exposure limits (PELs). The OSHA standard classifies construction and maintenance activities which could disturb ACM and specifies work practices and precautions which employers must follow when engaging in each class of regulated work. The standard also specifies requirements for handling materials containing asbestos in concentrations less than or equal to one percent.

C. Lead-based paint materials are assumed to be present within the existing pumping plant at the following locations:

1. All painted surfaces including but not limited to interior floors, walls and ceiling and building exterior.
   a. In Idaho, lead containing paint is regulated by EPA-Region 10 and OSHA. The EPA regulates lead use, removal, and disposal, and OSHA regulates lead exposure to workers. The EPA defines lead based paint (LBP) as paint, varnish, stain, or other applied coating that contains lead equal to or greater than 1.0 mg/cm^2, 5,000 mg/Kg, or 0.5% by dry weight as determined by laboratory analysis. For the purpose of the OSHA lead standard, lead includes metallic lead, all inorganic lead compounds, and organic

lead soaps. A synopsis of the OSHA regulations (29 CFR 1926.62) and the applicability are as follows:

b. The OSHA Lead Standard for Construction (29 CFR 1926.62) applies to all construction work where an employee may be occupationally exposed to lead. All work related to construction, alteration, or repair (including painting and decorating) is included. The lead-in-construction standard applies to any detectable concentration of lead in paint (LCP), as even small concentrations of lead can result in unacceptable employee exposures depending upon on the method of removal and other workplace conditions. Under this standard, construction includes, but is not limited to, the following:

1) Demolition or salvage of structures where lead, or materials containing lead, are present
2) Removal or encapsulation of materials containing lead
3) New construction, alteration, repair, or renovation of structures, substrates, or portions containing lead, or materials containing lead
4) Installation of products containing lead
5) Lead contamination/emergency clean-up
6) Transportation, disposal, storage, or containment of lead or materials containing lead on the site or location at which construction activities are performed
7) Maintenance operations associated with construction activities described above
8) OSHA defines lead paint as a paint that contains lead, regardless of the concentration. Currently, any proposed renovation/demolition is subject to the OSHA regulations (29 CFR 1926.62 – Lead Exposure in Construction) if lead is detected at any concentration.

2. Detectable lead quantities may constitute a lead dust hazard during renovation and demolition activities. Personnel performing renovation and demolition activities that may disturb painted components and building surfaces with concentrations of lead above the designated analytical detection limit should comply with all current OSHA regulations in order to minimize employee exposure. The OSHA regulation defines specific training requirements, engineering controls and working practices for construction personnel subject to this standard. Occupational exposure to lead occurring in the course of construction work, including maintenance activities, painting, alteration and repairs is subject to the OSHA Lead Exposure in Construction standard.

D. Contractor's attention is directed to Section 01 57 20 – Environmental Protection.

E. Owner assumes no responsibility for deductions, interpretations, or conclusions made by the Contractor based on information made available by the Owner.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

A. Perform construction and demolition operations, including management of subcontractors, to comply with: Applicable Federal, and local laws, orders, regulations concerning control, handling and disposal of asbestos and lead-based paint containing materials, and terms and conditions of applicable permits issued by permit issuing authority.

END OF SECTION

SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General provisions applicable to all demolition and removals.
2. Civil/site demolition and removals.
3. Architectural and structural demolition and removals.
4. Mechanical demolition and removals
5. Electrical demolition and removals.
6. Disposal of demolition debris, materials, and equipment.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, and incidentals as shown, specified and required for demolition, removals, and disposal Work.
2. The Work under this Specifications section includes, but is not necessarily limited to:
   a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, pavement, curbs, sidewalks, gutters, fencing, and similar existing materials, equipment, and items.
3. Demolitions and removals indicated in other Specifications sections shall comply with requirements of this Specifications section.
4. Perform demolition Work within areas shown or indicated.
5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition and removals Work.

C. Related Requirements:

1. 02 26 00 – Hazardous Materials Assessment
2. Section 31 10 00 - Site Clearing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Fire Protection Association (NFPA):
   a. 241, Safeguarding Construction, Alteration, and Demolition Operations.

B. Regulatory Requirements:

1. Demolition, removals, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T – Demolition), and all other Laws and Regulations.
2. Comply with requirements of authorities having jurisdiction.

C. Qualifications:

1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician(s) legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.
2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber(s) legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Review procedures under this and other Specifications sections and coordinate the Work that will be performed with or before demolition and removals.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Procedure Submittals:
   a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
      1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
      2) Other proposed procedures as applicable.
      3) Equipment proposed for use in demolition operations.
      4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
      5) Planned demolition operating sequences.
      6) Detailed schedule of demolition Work in accordance with the Schedule accepted by Engineer.
2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Specifications Section.
3. Qualifications Statements:
   a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.

1.5 SITE CONDITIONS

A. Owner makes no representation of condition or structural integrity of area(s) to be demolished or where removals are required by the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Notification:

1. Not less than 48 hours prior to commencing demolition or removal, advise Engineer in writing of planned start of demolition Work. Do not start removals without permission of Engineer.
2. Where demolition or removals has potential to affect adjacent properties, occupants, streets, or other public thoroughfare, transportation facilities, and utilities, furnish required notices to owners and occupants of properties, buildings, and structures that may be affected by the demolition of removal.
3. In accordance with Laws and Regulations, furnish to authorities having jurisdiction, including emergency services as necessary, appropriate notices of planned demolition and removals.
4. Submit to Engineer copies of notices furnished to adjacent property owners, occupants, and authorities having jurisdiction.

B. Protection of Adjacent Areas and Facilities:

1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and

free and safe access to and from, structures and properties unless allowed by the Contract Documents otherwise allowed in writing by Owner.

2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
3. Provide temporary partitions between demolition work areas and (a) areas that will be occupied during demolition and removals, and (b) areas accessible to the public or visitors. Temporary partitions shall be sturdy, braced plywood in good condition, of dimensions sufficient to adequately screen demolition work from view of occupants, public, and visitors. Maintain temporary partitions in place until demolition and removals work in the subject area is complete or until other Work requires removal of temporary partitions.
4. Provide appropriate temporary barriers, lighting, sidewalk sheds, and other necessary protection.
5. Repair damage to facilities that are to remain which such damages results from Contractor's operations.

C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, perform the following:

1. Should unforeseen, unknown, or incorrectly shown or indicated Underground Facilities be encountered, Contractor responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.
2. Water Piping and Related Facilities: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished. Ensure compliance with Laws and Regulations regarding water quality.
3. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; compressed air; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
4. Shutdown of utility services shall be coordinated by Contractor, assisted by Owner as required relative to contacting utility owners.

D. Remediation:

1. If unanticipated Hazardous Environmental Condition is believed to be encountered during demolition and removals, comply with requirements of Section 02 26 00 – Hazard Materials Assessment, and General Conditions, as may be modified by the Supplementary Conditions.

3.2 DEMOLITION - GENERAL

A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.

B. Pollution Controls:

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01 57 05 - Temporary Controls, and Laws and Regulations.
2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.

C. Explosives:

1. Explosives are not allowed at the Site. Do not use explosives for demolition and removal Work.

D. Building or Structure Demolition and Removals:

1. Unless otherwise approved by Engineer, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.
2. Demolish concrete and masonry in small sections.
3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
4. Break up and remove foundations, mats, and slabs-on-grade unless otherwise shown or indicated as remaining in place.
5. Temporary Bracing and Supports:
   a. Provide temporary bracing and supports sufficient to maintain safety, stability, and resist all loads to which the structure may be subject during demolition and removals, until entirety is permanently removed or permanently stabilized.
   b. Temporary bracing and supports shall be sufficient for associated dead load, live load, transient loading, and dynamic loads such as wind, seismic, and other loads to which the temporary bracing or support may be subject.
   c. Where appropriate, retain a professional structural engineer, duly licensed and registered in the same jurisdiction as the Site, to design temporary bracing and supports.

E. Salvage and Ownership:
1. Materials and equipment to remain Owner's property shall be:
   a. Carefully removed and appropriately handled by Contractor to avoid damage. Brace and secure equipment on pallets for delivery to Owner's storage location.
   b. Cleaned, listed, and tagged for storage.
   c. Protected from damage.
   d. Delivered to designated storage location at onsite as designated by Engineer or Owner.
2. Items to be and delivered onsite to Owner are as indicated in Table 02 41 00-A.

Table 02 41 00-A – Items to be Salvaged

Equipment Name/ Designation	Equipment Location	Deliver to Owner's Location
12-inch Butterfly Valves (3ea)	High Lift Vault	Onsite as directed by Owner
Air Compressor	Pumping Plant	Onsite as directed by Owner
Rail Crane (Motor and Hook Assembly)	Pumping Plant	Onsite as directed by Owner
Hydraulically Controlled Check Valves (6ea)	High Lift Vault	Onsite as directed by Owner
Forebay Steel Trash Racks (6ea)	Pumping Plant Forebay	Onsite as directed by Owner

3. Preparation of Owner's existing equipment for storage:
   a. Where appropriate, identify each component with markings or tags to indicate its position in the assembly and the assembly of which it is part.
   b. Place small parts in appropriate, durable boxes and clearly mark contents on the outside of box or container.
   c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.
   d. Grease grease-lubricated bearings.
   e. Replace breather plugs with solid plugs.
   f. Attach unit to suitable crate bottom.
   g. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.

h. Construct crate of wood slats around top and sides of unit.

i. Attach permanent instruction tag to outside of crate stating “This unit has been prepared for storage. Replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up.”

F. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by Engineer.

3.3 STRUCTURAL REMOVALS

A. Remove structures to lines and grades shown or indicated, unless otherwise directed by Engineer. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at Contractor’s risk and expense and such excess removals shall be reconstructed to satisfaction of Engineer without additional cost to Owner.

B. Recycling and Reuse of Demolition Materials:

1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by Engineer.
2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.

C. After removing concrete and masonry walls or portions thereof, mats, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.

D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.

1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 inches below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.

E. Removal of Anchorages and Protruding Metals:

1. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, and where existing metals (and to be removed) protrude from concrete, remove the anchors and other metal to not less than 1.5 inches beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface.
2. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by Engineer.

F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.

G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Specifications section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

A. Mechanical demolition and removal Work includes dismantling and removing existing:

1. Piping systems and ductwork systems.
2. Mechanical equipment and appurtenances.
3. Mechanical elements of instrumentation and control systems, such as sensors and transmitters and similar items.
4. Mechanical removals include cutting and capping as required, except that cutting of existing piping and ductwork to make connections is included under Section 01 73 29 - Cutting and Patching.
5. Mechanical removals as required herein apply to systems exposed to view, hidden from view, and Underground Facilities. Mechanical removals may require work in spaces that may be classified confined spaces.

B. Life-Safety Systems:

1. Retain existing life-safety systems, including but not limited to fire suppression systems, in place for as long as possible prior to performing associated demolition and removals.
2. Where demolishing buildings or structures equipped with life-safety systems, remove or deactivate life-safety systems only in the area where active demolition operations are in progress.

C. Demolition and Removals of Piping, Ductwork, and Similar Items:

1. Scope:
   a. Safety purge piping and tanks (as applicable) of chemicals, fuel, solids, liquids, and gases (as applicable) and make safe for removal and capping. Discharge contents of existing piping appropriately while avoiding damaging property; restricting access to or use of property; and cresting unsafe, unsanitary, nuisances, and noisome conditions.
   b. To the extent shown or indicated, remove existing piping conveying water (potable and non-potable), waste and vent, fuel (liquids and gases), heating fluids (such as water-glycol solutions), chemicals, solids and slurries, sludge, wastewater, other fluids, and processes gases, and other piping.
   c. Remove piping to the nearest structurally sound (or “solid”) piping support, and provide caps on ends of remaining piping.
   d. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
2. Caps, Closures, Blind Flanges, and Plugs – General (All Piping and Ducts):
   a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
   b. Where used in this Specifications section, the term “cap” means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
   c. Caps shall be compatible with the piping or ductwork on which the cap is installed, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.
   d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Specifications section only when expressly so shown or indicated in the Contractor Documents or when allowed by Engineer.
3. Underground Facilities:
   a. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.

4. Waste and Vent Piping; Ductwork:
    a. Remove waste and vent piping, and ductwork to extent shown and cap as required.
    b. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials as existing, and fully compatible with ensign materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.

D. Equipment Demolition and Removals:
1. To the extent shown or indicated and as required for the Work, remove existing mechanical equipment, including (but not limited to):
    a. Heating, ventilating, and air conditioning equipment.
    b. Flow control gates and valves.
    c. Hoisting equipment.
    d. Bulk materials conveying equipment.
    e. Blowers, compressors, air filters, air dryers, and similar equipment.
    f. Pumps.
    g. Tanks.
    h. Appurtenances (including motors, drive systems, controls, cooling water and seal water systems) as shown, indicated, and required for completion of the Work.
2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly and removal shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.
3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.
4. Tanks and Equipment Containing Process Material:
    a. Purge contents in accordance with Paragraph 3.5.A of this Specifications Section and other requirements of the Contract Documents, as applicable.
    b. When removing generators, remove associated fuel storage tanks unless otherwise indicated to remain.
    c. Where contents of tank or equipment item may pose a potential hazard, such as hydrocarbon fuels or chemicals, properly dispose of contents in accordance with Laws and Regulations and the Contract Documents.
    d. Where tank or equipment contains wastewater or liquid sludge, and the Site is a wastewater treatment facility, transport and dispose of stored contents onsite at location acceptable to Owner and facility manager (if other than Owner) unless otherwise indicated in the Contract Documents. If Site is other than a wastewater treatment facility, dispose of contents appropriately in accordance with Laws and Regulations.
    e. Where tank or equipment contains solid or slurry-type material, remove, handle, and transport the contents and appropriately dispose of the materials offsite in accordance with Laws and Regulations, unless otherwise indicated in the Contract Documents.
5. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Specifications section.
6. Remove small-diameter piping back to header unless otherwise indicated.
7. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.
8. Instrumentation and Control Systems Removal:
    a. Remove instrumentation and controls equipment in accordance with this Specifications section's requirements for mechanical removals and electrical removals.

3.5 ELECTRICAL REMOVALS

A. Electrical demolition Work includes removing existing:

1. Disconnecting cabling from motors, electrical sources, control panels, control stations, instrumentation and control items, and similar devices and equipment.
2. Conduits, raceways, cable trays, hangers and supports, cabling, and related items.
3. Switches, panelboards, control stations, and similar items.
4. Transformers, distribution switchboards, control panels, motors, starters, variable speed controllers, and similar items.
5. Lighting fixtures and related items.
6. Utility poles, site lighting standards, and overhead cabling.
7. Appurtenances and miscellaneous electrical equipment, as shown, specified, or required.

B. Electrical Removals – General:

1. Comply with Laws and Regulations, including the National Electric Code.
2. Lock Out and Tagging:
   a. Contractor shall lock out and tag circuit breakers and switches operated by Ownerand shall verify that affected cabling are de-energized to ground potential before commencing electrical removals Work.
   b. Upon completion of electrical removals Work, remove the locks and tags and promptly advise Resident Project Representative (RPR) or Engineer and facility manager that existing facilities are available for use.
3. Remove existing electrical equipment, fixtures, and systems to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
4. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated.
5. Store removed motors, microprocessors and electronics, and other electrical gear to be reused in accordance with its manufacturer's recommendations and requirements of the Contract Documents.

C. Motor Control Centers and Switchgear:

1. Remove or modify motor control centers and switchgear as shown or indicated.
2. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.

D. Removal of Cabling, Conduits, Raceways and Similar Items:

1. Verify the function of each cable before disconnecting and removing.
2. Remove cabling, conduits, hangers and supports, and similar items back to the power source or control panel, unless otherwise shown or indicated.
3. Remove cabling, conduits, and similar items where shown or indicated for removal. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to Engineer.
4. Disassemble and remove exposed conduits, junction boxes, other electrical appurtenances, and their supports.
5. Repair all areas of the Work to prevent rusting on exposed surfaces.
6. Underground Electric:
   a. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
   b. Where shown or indicated, remove direct-burial cabling. Openings in buildings for entrance of direct-burial cabling shall be patched with repair mortar or other material approved by Engineer for such purpose, and made watertight.

E. Electrical Service Entrances and Outdoor, Overhead Electrical Utilities:

1. Existing poles and overhead cabling shall be removed or abandoned as shown and specified.
2. Completely remove from the Site poles not owned by electric utility, including site lighting standards and appurtenances, shown or indicated for removal.
3. Existing substation(s) and poles owned by electric utility will be removed by the electric utility.
4. Make necessary arrangements with electric utility owner for removal of utility owner's transformers and metering equipment after new electrical system has been installed and energized.

F. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as Owner's property, shall be removed and properly disposed off-Site as required in accordance with Laws and Regulations.

3.6 DEMOLITION OF SITE IMPROVEMENTS

A. Pavement, Sidewalks, Curbs, and Gutters:

1. Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
2. To cut pavement, sidewalks, curbs, and gutters, use machinery or tools that provides a smooth-cut edge, appropriate for the required. Where cut edges are not smooth, repair the cut edge to remain to provide a smooth, even appearance.

B. Fencing, Guardrails, and Bollards:

1. Remove to the limits shown or indicated on the Drawings.
2. Completely remove below-grade posts and concrete.

C. Manholes, Vaults, Chambers, and Handholes:

1. Remove to the limits shown or indicated on the Drawings.
2. If not shown or indicated on the Drawings, remove to not less than three feet below finished grade indicated on the Drawings.

D. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes:

1. Remove to the extent shown or indicated on the Drawings.
2. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Specifications section.

E. Landscaping: Comply with Section 31 10 00 - Site Clearing.

F. Other Site Improvements: When the Contract Documents require removal of other site improvements not addressed above, copy with Contract requirements for removal of buildings or structures.

3.7 DISPOSAL OF DEMOLITION DEBRIS

A. Disposal – General:

1. Promptly remove from the Site all debris, waste, rubbish, material, and equipment resulting from demolition and removal operations. Promptly upon completion of demolition and removal operations, remove from the Site construction equipment used in demolition Work.
2. Do not sell at the Site demolition materials or removed equipment. If materials, equipment or debris will be sold by Contractor, remove the items from the Site and perform the sale or transaction elsewhere, in accordance with Laws and Regulations.
3. Cleaning and Removal of Debris: Comply with the General Conditions, Supplementary Conditions, and Section 01 74 00 - Cleaning.

B. Transportation and Disposal:

1. Non-Hazardous Materials, Equipment, and Debris: Properly transport and dispose of non-hazardous demolition materials, equipment, and debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Constituents of Concern such as (but not limited to) asbestos, PCBs, petroleum, hazardous waste, radioactive material, or other material designated as hazardous in Laws or Regulations.
2. Hazardous Materials, Equipment, and Debris: When handling and disposal of items containing Constituents of Concern is included in the Work, properly transport and dispose of such items in accordance with the Contract Documents and Laws and Regulations.

C. Submit to Engineer information required in this Specification Section on proposed facility(ies) where demolition materials, equipment, and debris will be recycled. Upon request, Engineer or Owner, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist Engineer and Owner.

END OF SECTION

DIVISION 03

CONCRETE

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REPAIR AND REHABILITATION OF EXISTING CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation and assessment of existing concrete for repair and rehabilitation:
   a. Concrete removal for repairs.
   b. Preparation of exposed reinforcing steel.
   c. Preparation for joint sealant installation.
2. Repair of damaged (and deteriorated) concrete.
   a. Application of repair mortar.
   b. Repair of exposed items embedded in concrete.
3. Expansion joint repair.

B. Scope:

1. Contractor shall provide all materials, equipment, labor, tools, services, and incidentals necessary to repair and rehabilitate existing concrete, whether damaged or deteriorated, at locations shown on the Drawings or at locations indicated by Engineer, in accordance with the Contract Documents.
2. Re-sealing concrete joints as shown on the Drawings, and at other locations directed by Engineer, and indicated in this Section.
   a. Included in the lump sum price for joint sealant Work are repairs of existing concrete adjacent to the associated joint sealant Work, in accordance with this Section.
3. Surface repairs of new concrete Work are addressed in Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
4. Repair of cracks in concrete existing prior to the Contract is addressed in Section 03 64 23 - Crack Repair and Injection.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 03 15 19 - Anchorage to Concrete.
2. Section 03 21 00 - Reinforcement.
3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
4. Section 03 64 23 - Crack Repair and Injection.
5. Section 07 92 00 - Joint Sealants.

1.2 PRICE AND PAYMENT PROCEDURES

A. Repair of new concrete Work provided by Contractor are included in the Work of the associated bid/pay item under which the subject new concrete Work was provided.

1.3 REFERENCES

A. Terminology:

1. This provision indicates terminology used in this Section and in other Contract Documents that coordinate with this Section. Such terminology may or may not be indicated using initial capital letters and, when used in relation to the Work of this Section, have the meanings indicated below.

2. "Existing concrete damage" means damage to existing concrete surfaces deeper than 1/8 inches, such as:
   a. Concrete corrosion.
   b. Corroded items embedded within concrete or through the concrete surface.
   c. Spalls.
   d. Cracking at depth and arrangement that, in Engineer's sole opinion, cannot be repaired in accordance with Section 03 64 23 - Crack Repair and Injection.
3. "Installer" means the entity installing or applying repair materials at the Site. The terms "installer" and "applicator" have the same meaning. Installer or applicator may be Contractor or Subcontractor.
4. "MPII" means, "manufacturer's printed installation instructions".
5. "Rehabilitation" means repairing and restoring concrete to structurally-sound, durable condition suitable for the structure's intended purpose as determined by Engineer, including repair of existing concrete damage in accordance with this Section and other applicable provisions of the Contract Documents.
6. "Water-bearing structure" means concrete structure with a surface that is normally, or may be, in contact with water or process fluids or slurries during typical operation of the completed Project, including, but not limited to: tanks, channels, wet wells, distribution chambers, dams, and the like. Also, where specifically indicated on the Drawings, "water-bearing structures" includes basements and structures extending below the ordinary, wet-season groundwater surface.
7. Other terminology used in this Section is consistent with terminology of ACI CT.

B. Reference Standards:
1. American Concrete Institute (ACI):
   a. CT, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 308, Standard Practice for Curing Concrete.
2. ASTM International (ASTM):
   a. C150, Standard Specification for Portland Cement.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   c. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   d. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
   e. D1682, Breaking Load and Elongation of Textile Fabric.
   f. D1876, Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
   g. D4060, Abrasion Resistance of Organic Coatings by the Taber Abraser.
   h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   i. D4259, Standard Practice for Abrading Concrete.
   j. D4263, Indicating Moisture in Concrete by the Plastic Sheet Method.
   k. D7234, Standard Test Method for Pull-off Adhesion Strength of Coatings on Concrete Using Portable Pull-off Adhesion Tests.
3. International Concrete Repair Institute (ICRI).
   a. 310.1R, Guide for Surface Preparation.
   b. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Steel Corrosion.
4. Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 13/NACE No. 6, Surface Preparation of Concrete.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Installer:
   a. Installer of materials for rehabilitation of existing concrete shall possess not less than five years of relevant experience performing concrete rehabilitation of similar type, scope, and complexity to that required for this Project.
   b. Certification or Approval by Materials Manufacturer:
      1) Installer (as either business entity or individual) of materials associated with rehabilitation of existing concrete shall be certified or expressly approved in writing, by manufacturer of materials to be provided.
      2) As an option, installer may be certified or approved, in writing, at the Site during initial Work of this Section, in accordance with this Section's Paragraph 3.4.D.
   c. Submit documentation of qualifications and experience in sufficient detail to demonstrate to Engineer's satisfaction compliance with requirements of this Section's qualifications requirements.
2. Structural Concrete Repairer:
   a. This provision is in addition to qualifications requirements applicable to installers of the Work under this Section. This provision applies to business entities physically performing rehabilitation of structural concrete.
   b. Structural concrete repairer shall have not less than five years' current, relevant experience in repairing and rehabilitating concrete structures in facilities of generally similar environmental exposures as the Work of this Section for this Project
   c. Submit documentation of qualifications and experience in sufficient detail to demonstrate to Engineer's satisfaction compliance with requirements of this Section's qualifications requirements.
3. Joint Sealant System Installer:
   a. This provision is in addition to qualifications requirements applicable to all installers of the Work of this Section. This provision applies to entities performing concrete joint sealant system repair or rehabilitation Work.
   b. Entity performing joint sealant system Work shall possess not less than 10 years' relevant experience in waterproofing concrete joints, crack and leak repair, and concrete coating application on projects of similar size, complexity, and environment as the concrete joint sealing Work on this Project.
   c. Entity performing concrete joint sealant system Work shall have completed not less than five projects of size, type, and complexity similar to the Work under this Section within the most-recent period indicated in the paragraph immediately above, on structures that have been in service for not less than three years each. Projects shall have utilized the required type of joint sealant system materials indicated for the Work.
   d. Entity performing concrete joint sealant system Work shall be certified or approved, in writing, by joint sealant system manufacturer (whose product is used in the Work) to furnish and install the required concrete joint sealant system materials.
   e. Submit documentation of qualifications and experience in sufficient detail to demonstrate to Engineer's satisfaction compliance with requirements of this Section's qualifications requirements

B. Mock-Ups:

1. Mock-ups are Samples that, when approved by Engineer, indicate minimum standard of quality for the associated Work. Standard of quality of mock-ups shall be not less than that required by the Contract Documents.
2. If so approved by Engineer, mock-ups may become part of completed Work.
3. Maintain, segregate, identify, and protect mock-ups during performance of the Work to allow Engineer to readily compare the Work with approved mock-up.

4. When mock-up is not part of the completed Work, remove mock-ups when directed by Engineer. If mock-up is part of the completed Work, remove protection and indication of mock-up when so directed by Engineer.
5. Provide mock-up for each type of concrete rehabilitation required by this Section for which the Contract has an associated bid/pay item, including finish.
6. Size of each mock-up shall be acceptable to Engineer. Concrete surface repair mock-ups shall be not less than 2 feet by 2 feet each. Expansion joint repair mock-ups shall be not less than 3 feet long, each.
7. Where mock-ups will be part of the completed Work, Contractor and Engineer will jointly select the location of each mock-up.
8. Concrete surface repair mock-ups shall include:
   a. Sample of patched tie or bughole.
   b. Sample of all jointing specified.
   c. Sample of mortar repair.
9. Expansion joint repair mock-ups shall include:
   a. Repaired expansion joint.
   b. Expansion joint seal.
   c. Rehabilitation of adjacent concrete surfaces.
10. Also provide concrete surface repair mock-up of wall having polymer-modified cementitious coating.
    a. Mock-up shall be stepped to show surface preparation, repairs and coating in all stages of application.
11. Mock-up areas shall be readily identifiable during construction. Provide appropriate temporary signage indicating status as mock-up and protect the mock-up.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule (table) indicating, for each type of concrete rehabilitation Work required by this Section, the material type and product manufacturer proposed for each application.
   2. Product Data:
      b. Manufacturer's published, technical data for each manufactured material proposed for use in the Work of this Section.
      c. Manufacturer's written certification that proposed materials comply with associated reference standards cited in this Section.
   3. Samples:
      a. Advise Engineer in writing when required mock-ups will be provided and the location proposed for each.
   4. Test Procedures:
      e. Procedure for pre-repair condition survey required in this Section's Article 3.1, including method for recording results of survey.
      f. Written method of performing pull-off testing of repair material and testing equipment information and accessory materials proposed for use in testing.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Laboratory test reports (for previously-tested materials identical to those to be furnished) and material manufacturer's certificates verifying that ingredients comply with the Contract Documents and have a minimum of six months' residual shelf life at the time of shipment to the Site.

b. Certification from Supplier stating that material is suitable for the intended use on this Project.

c. Certification that materials proposed for use are compatible with each other, when such materials will contact each other, and will not interfere with bonding of future floor or wall finishes.

2. Test and Evaluation Reports:

a. Results of pre-rehabilitation condition survey required in this Section's Article 3.1.

3. Manufacturer's Instructions:

a. Manufacturer's instructions for all concrete rehabilitation materials, for handling, storing, and installing materials.

4. Field Quality Control Submittals:

a. In-situ pull-off test results for joint sealant system.

5. Qualifications Statements:

a. Installer: Documentation of qualifications in accordance with this Section's "Quality Assurance" Article.

b. Manufacturer's written approval of installer or certification of training performed at the Site in accordance with Paragraph 3.4.D of this Section.

1) Affidavit, signed by either materials manufacturer or by installer's business entity, indicating that manufacturer of rehabilitation materials has instructed installer in proper handling and installation of each rehabilitation material to be used in the Work.

c. Entity performing structural concrete repair Work.

d. Entity performing joint sealant system Work.

C. Closeout Submittals: Submit the following:

1. Affidavit of compliance from joint sealant system manufacturer, certifying that sealants were installed at the Site in accordance with manufacturer's written instructions and recommendations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with material manufacturer's written instructions and recommendations regarding delivery, handling, and storage or materials to be incorporated into the Work.

B. Storage:

1. Store materials in tightly-sealed, original containers, off the ground and in dry location with humidity controls.

2. Do not store in direct sunlight.

3. Protect materials from temperature extremes and avoid freezing temperatures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Anti-Corrosion Bonding Agent:

a. Sika Corporation.

b. Euclid Chemical Company.

c. Master Builders Solutions.

d. Or equal.

2. Epoxy Bonding Adhesive:

a. Sika Corporation.

b. Euclid Chemical Company.
c. Or equal.

3. Repair Mortar:
   a. Master Builders Solutions.
   b. Euclid Chemical Company.
   c. Five Star Products, Inc.
   d. Sika Corporation.
   e. Or equal.

2.2 MATERIALS

A. Materials that will be in direct contact with potable water or water that will be treated to become potable shall be certified in accordance with ANSI/NSF 61 and suitable for prolonged immersive exposure to chlorinated water with a total residual of up to 5 mg/l.

B. Bonding Agents:
   1. Bonding agents and adhesives shall have pot life that allows proper placement of new material against existing material in accordance with manufacturer's written instructions.
   2. For repair of existing concrete damage, when no reinforcing steel is exposed, and where specifically shown or indicated on the Drawings, use epoxy bonding adhesive.
   3. For repair of existing concrete damage, when reinforcing steel is exposed, and where specifically shown or indicated on the Drawings, use anti-corrosion bonding agent.
   4. For repair of new concrete: Comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

C. Water:
   1. Potable.
   2. Clean and free from deleterious substances.
   3. Free of oils, acids and organic matter.

D. Reinforcing Steel: In accordance with 03 21 00 - Reinforcement.

E. Epoxy Patch Seal:
   1. For use as seal on patches at repair of existing concrete damage and as otherwise shown or specified in the Contract Documents.
      a. Sikadur 32 Hi-Mod LPL by Sika Corporation.
      b. Or equal.

F. Anti-Corrosion Bonding Agent:
   1. Three-component, moisture tolerant, cementitious bonding agent manufactured for purpose of bonding fresh concrete to hardened concrete and providing anti-corrosion coating to embedded reinforcing materials.
      a. Sika Armatec 110 EpoCem by Sika Corporation.
      b. Duralprep A.C. by Euclid Chemical Company.
      c. Or equal.

G. Epoxy Bonding Adhesive:
   1. For use where bonding new concrete or patch material to existing concrete.
   2. Two-component, moisture insensitive adhesive manufactured for purpose of bonding fresh concrete to hardened concrete.
      a. Sikadur 32 Hi-Mod LPL by Sika Corporation.
      b. Euco No. 452 MV by Euclid Chemical Company.
      c. Or equal.

H. Repair Mortar:

1. Pre-packaged cement-based, modified (polymer or latex) product specifically formulated for repair of concrete surface defects, with the following properties:

Physical Property	Value	ASTM Standard
Compressive strength (minimum)		C109
at one day	2000 psi	
at 28 days	6000 psi	
Bond strength (minimum)		C882 (*)
at 28 days	1800 psi	

(*) Modified for use with repair mortars.

2. Trowelable, selection based on horizontal, vertical, or overhead application.
3. Where the least dimension of the placement, in width or thickness, exceeds 1.5 inches, repair mortar shall be extended by addition of aggregate per MPII.
4. Acceptable Products:
   a. Five Star Structural Concrete by Five Star Products, Inc.
   b. SikaRepair SHA, SikaTop 123 Plus, SikaTop 111 Plus by Sika Corporation.
   c. Verticoat by Euclid Chemical Company.
   d. Emaco S88-CI, Emaco S66-CI by BASF Corporation.
   e. Or equal.

I. Epoxy Coating:

1. Use as a coating over concrete repairs and at repaired embedded items in concrete where shown or indicated on the Drawings.
2. Pigmented, two-component, 100% solids, moisture-tolerant epoxy resin specifically formulated to serve as a protective, corrosion-resistant coating to all common structural substrates.
3. Acceptable Products:
   a. Sikagard 62 by Sika Corporation.
   b. Or equal.

J. Epoxy Resin Adhesive Sealing System:

1. Provide sealing system consisting of the following components:
   a. Epoxy Resin Adhesive:
      1) Two-component, 100% solids, high-strength, non-sag structural epoxy paste adhesive.
      2) Color: Gray.
      3) Minimum Pot Life: 30 minutes.
      4) Acceptable Products:
         a) Sikadur 31 Hi-Mod Gel .
         b) Or equal.
   b. Hypalon Sheeting:
      1) Composed of Hypalon rubber with perforations along bonding edges of sheeting to provide mechanical key.
         a) Shall have the ability to be vulcanized with aromatic hydrocarbon solvent to allow its adhesion to an epoxy resin adhesive.
         b) Sheet Dimensions: 8 inches wide and 40 mils thick.

c) Provided with a removable center expansion strip.

c. Activating Solvent:

1) Aromatic hydrocarbon with a specific gravity of 0.86.

2) All sealing system components shall be fully compatible with each other.

3) Acceptable Products:

a) Sikadur Combiflex System by Sika Corporation.

b) Or equal.

K. Polyurethane Joint Sealing System:

1. Provide high-solids, two-component liquid, cold-applied, asphalt extended urethane elastomer that cures to durable abrasion-resistant film, forming flexible, water-impermeable barrier.

2. Provide all components from a single manufacturer to ensure compatibility of components with each other, except for hydrophobic polyurethane grout material.

3. Concrete Surface Primer: Acceptable products:

a. CIM 61BG Epoxy Primer, by CIM Industries.

b. Or equal.

4. Tack Coat and Top Coat: Acceptable products:

a. CIM 1061, by CIM Industries.

b. Or equal.

5. Joint/Crack Filler: Acceptable products:

a. CIM 1000TG, by CIM Industries.

b. CIM 1000TG Cartridges, by CIM Industries.

c. Or equal.

6. Cant Strip Material: Acceptable products:

a. CIM 1000 TG Cartridges, by CIM Industries

b. Or equal..

7. Reinforcing Fabric (Scrim): Acceptable Products:

a. CIM Scrim, by CIM Industries.

b. Or equal.

8. Bonding Agent (for re-application of CIM 1061 if recoat window exceeded):

a. Acceptable products:

1) CIM Bonding Agent, by CIM Industries.

2) Or equal.

b. Material:

1) Organo-silane compound dispersed in isopropyl alcohol.

9. Hydrophobic Polyurethane Grout: Acceptable products:

a. SikaFix HH LV, by Sika Corporation.

b. De Neef Hydro Active Flex LV, by GCP Applied Technologies.

c. Or equal.

L. Expansion Joint Sealant and Backer Rod:

1. Provide in accordance with Section 07 92 00 - Joint Sealants.

PART 3 - EXECUTION

3.1 PREPARATION AND ASSESSMENT

A. As indicated in Article 1.1 of this Section, repair of surface defects in new concrete provided under the Contract and repair of cracks in concrete are addressed in other Specification Sections.

B. Condition Survey:

1. Contractor and Engineer shall jointly perform condition survey of each existing concrete structure included in the scope of the concrete repair Work before scheduling and performing the associated repair Work.
2. Contracting and payment for specialty inspections and tests by third-parties will be by Owner.
3. Prior to Condition Survey:
   a. Submit to Engineer, and obtain Engineer's acceptance, of procedure for performing condition survey. Indicate proposed date(s) of the condition survey and other procedures for inspecting and documenting extent of concrete repair Work to be performed.
   b. Prior to the condition survey, power-wash all concrete surfaces within the scope of the concrete repair Work. Power-wash at not less than 4,000 psi using orbital nozzle.
4. Condition survey shall include, but is not necessarily limited to:
   a. Visual inspection for:
      1) Deficiencies in joints.
      2) Cracks.
      3) Leakage and efflorescence.
      4) Scaling.
      5) Spalling
      6) Exposed reinforcing.
      7) Previous repairs.
   b. Extent of chemical attack using phenolphthalein.
   c. Delamination survey.
   d. Half-cell measurements for corrosion potential of reinforcing.
5. Results of Condition Survey:
   a. Submit written results of condition survey to Engineer promptly following the condition survey at the Site.
   b. Condition survey results shall clearly indicate the location, nature, size, length, width, and depth of all deficiencies in existing concrete in the area(s) surveyed.
   c. Engineer will use results of condition survey to determine extent of repair Work required.
6. Engineer's Direction to Contractor:
   a. After consulting with Owner as necessary, Engineer will transmit to Contractor written direction on extent of concrete repairs required.
   b. Engineer will issue such direction promptly after Engineer's receipt of acceptable results of condition survey. Allow in the Progress Schedule 14 days for issuance of Engineer's written direction.
   c. Where such Work would either exceed Contract quantities of associated lump sum price or requires Work not in the Contract's bid/pay items, an appropriate Contract modification will be issued.

C. Concrete Removal:

1. Remove all loose and unsound concrete from areas to be repaired, in accordance with ICRI Guideline 310.1R, as modified by the Contract Documents.
2. Removals:
   a. At areas of damage or deterioration of existing concrete, saw-cut the perimeter of unsound concrete surface areas, to depth of not less than 1/2 inches.
   b. Saw-cuts to be perpendicular to or slightly undercutting existing concrete surface. Concrete removal boundaries shall be straight and aligned parallel to opposite boundary edges resulting in repair areas that are approximately rectangular.
   c. Remove all existing concrete from within the saw-cut repair boundary to of not less than 1/2 inches.
   d. Featheredges are unacceptable.
3. Clean surfaces of repair areas in accordance with ASTM D4258 to remove dust, dirt, grease, and other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
4. Abrasive-blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
5. Chip concrete substrate to obtain a surface profile of 1/16 inches to 1/8 inches deep with new fractured aggregate surface. The area to be repaired shall not be less than 1/2 inches in depth.
6. Concrete removal shall extend along any exposed existing reinforcing to locations along the bar that are free of bond inhibiting corrosion and where the bar is well-bonded to surrounding concrete.
7. Rinse surface with clean water and allow surface water to evaporate prior to repairing the surface.

D. Preparing Exposed Steel Reinforcing:

1. Clean and prepare exposed embedded steel reinforcing in accordance with ICRI Guideline 310.1R and the Contract Documents.
2. Where one-half or more of the steel reinforcing diameter is exposed, either by existing conditions or concrete removal, bond between concrete and steel reinforcing is inhibited or lost completely, or corrosion is present, remove concrete to provide not less than 1 inch clearance around the entire perimeter and along the entire exposed length of the steel reinforcing.
3. If existing, exposed steel reinforcing is cut through, cracked, or cross-sectional area is reduced by more than 20%, provide new steel reinforcing bar the same size as existing steel reinforcing. Lap the new bar with existing in accordance with ACI requirements. Coat all new and existing steel reinforcing with anti-corrosion bonding agent, as specified in this Section. Abrasive-blast exposed reinforcing to remove contaminants and corrosion to provide white-metal, bright steel finish.

E. Preparation for Joint Sealant System Installation:

1. Provide adequate surface preparation in area of each joint sealant repair, to not less than 6 IN from face of joint, on each side of joint.
2. Surface preparation shall remove existing concrete laitance, loose material, oil, grease, and shall expose tops of underlying aggregate to an ICRI concrete surface profile of 4-6. The following methods may be used:
   a. Abrasive-blasting in accordance with ASTM D4259.
   b. High-pressure water blasting at not less than 5,000 psi, in accordance with ASTM D4259.
   c. Shot-blasting in accordance with ASTM D4259, at horizontal surfaces only.
3. Concrete joint areas to receive joint sealant system shall be fully dried prior to application of joint sealant system. Test substrate moisture at not less than three locations per structure to confirm moisture. The following methods may be used to determine moisture:

a. Plastic Sheet Method (ASTM D4263): Pass/fail.
b. Relative Humidity Test (ASTM F2170): Less than 85%.
c. Calcium Chloride Test: Less than 5 pounds per 1000 square feet per 24 hours.
d. Radio Frequency Test: Less than 5% moisture.

4. Perform adhesion tests at not less than three locations per structure in mock-up (non-joint) areas to verify adequacy of the joint surface preparation. Perform modified T-Peel (ASTM D1876) field test:
   a. Apply duct tape on substrate.
   b. Apply the coating top coat material to the substrate, fully lapping onto the duct tape.
   c. After coating material has fully cured, cut 1 inch wide strips through coating material, perpendicular to duct tape strip: a minimum of three pull tests per testing location.
   d. Peel up the outside edge of duct tape and provide tarp clip.
   e. Hook a fish weighing or similar scale through the tarp clip and pull perpendicular to the substrate to point of coating adhesion failure and record the load at failure. Scale used for this field measurement shall be calibrated immediately prior to testing.
   f. Minimum acceptable coating adhesion force at failure shall be 15 pounds; no test performed shall demonstrate adhesion below this threshold for surface preparation to be acceptable.
5. Inspect concrete surfaces in area of surface preparation and repair as follows:
   a. Blast/expose all bug-holes to eliminate blind side surfaces.
   b. Cracks less than 1/16 inches wide that extend through the joint coating areas do not require special treatment.
   c. Cracks 1/16 inches to 1/8 inches wide that extend through the joint coating areas shall be stripe-coated for not less than 2 inches on each side and filled with CIM (trowel grade) prior to application of the joint sealant system (after moisture content and surface preparation are acceptable in accordance with the Contract Documents)
   d. Cracks greater than 1/8 inches wide and cracks that experience movement (that extend through the joint coating areas) shall be reinforced with scrim material, similar to the joint coating, prior to sealing the joints.
   e. Cracks greater than 1/4 inches -wide: Provide backer rod, in addition to complying with the paragraph immediately above.
   f. In areas of joint coatings, patch surface spalls and other concrete defects in accordance with requirements for concrete repairs indicated in this Section.
6. Inspect existing joint filler material. If defects in existing joint filler material extend greater than 1/2 inches deep, or if determined by sealant installer to be unsatisfactory, remove not less than 1 inch of existing filler material and pack joint with appropriately sized backer rod soaked in polyurethane grout. Trim grout foam/backer rod flush with surface of concrete once cured. Joints to be coated shall be filled according to this provision and trimmed flush prior to application of coating system.
7. Provide and tool 1 inch minimum cant strips at wall-slab and slab-column joints to be coated. Allow cant strips to cure prior to applying coating system.
8. Perform surface preparation, substrate moisture field tests, adhesion test results, treatment of defects in joint coating areas, and filling (as required) of existing joints for approval by coating manufacturer's technical representative prior to installing joint coating system.

3.2 INSTALLATION AND APPLICATION

A. Environmental Conditions for Installation:

1. Comply with material manufacturer's written instructions for substrate temperature and moisture content, ambient temperature, and ambient humidity, ventilation, and other conditions affecting performance of concrete repair materials.
2. Do not repair existing concrete damage when ambient temperature is or is expected to be below 50 degrees F. If necessary to maintain the progress Schedule, enclose and heat

area to between 50 and 70 degrees F during repair of surface defects and curing of patching material. Use only indirect fired heating using clean-burning fuel.

3. If proper environmental conditions do not comply with the Contract Documents and manufacturer's instructions, do not perform the Work until such conditions are acceptable. Provide means to bring conditions into compliance by providing temporary environmental controls, enclosures, and other temporary construction and temporary facilities.
4. Contractor is not eligible for changes in Contract Times or Contract Price for delays or costs incurred to bring environmental conditions for installation into compliance.

B. Existing Concrete Damage Repair:

1. Type I Repair:
   a. Provide epoxy bonding adhesive and repair mortar.
2. Type II Repair:
   a. Provide epoxy bonding adhesive, if no reinforcing steel is exposed. Use anti-corrosion bonding agent, if reinforcing steel is exposed.
   b. Prepare exposed reinforcing steel in accordance with Paragraph 3.1.D of this Section.
   c. Provide repair mortar:
      1) Provide 3/8 inches aggregate in accordance with MPII.
3. Type III Repair:
   a. Provide anti-corrosion bonding agent.
   b. Prepare exposed steel reinforcement per the requirements of Paragraph 3.1.B.
   c. Provide new adhesive anchor dowels as shown on the Drawings and as indicated in Section 03 15 19 - Anchorage to Concrete.
   d. Provide repair mortar:
      1) Provide 3/8 inches aggregate in accordance with MPII.

C. Repair Mortar Application:

1. Comply with MPII for mixing and placement of repair mortar.
2. After initial mixing of repair mortar, do not introduce additional water to change consistency. Discard repair mortar if consistency becomes too stiff to place.
3. Place repair mortar to not less than recommended minimum thickness indicated in the MPII and in no event less than 3/8 inches.
   a. Apply repair mortar in accordance with the following minimum requirements:
      1) Not less than 3/8 inches over existing sound, exposed coarse aggregate.
      2) Not less than 2 inches of cover (unless otherwise required) over exposed reinforcing steel.
4. At horizontal applications, repair mortar shall be screeded and bull-floated to the proper elevation, to ensure all surface moisture will drain freely and properly without puddle areas.
5. Provide repair mortar in even, uniform plane to restore the concrete member to its original surface finish and plane.
   a. Tolerance for being out-of-plane shall be such that gap between a 1 foot straight edge and repair mortar surface shall not exceed 1/4 inches, and gap between a 4 feet straight edge and repair mortar surface shall not exceed 3/8 inches. This shall apply to straight edges placed in any orientation at any and all locations on the repair mortar surface.
6. Prevention of Drying:
   a. Prevent exposed plastic mortar surfaces from drying. Provide windbreaks, foggers, and evaporation retarders, as necessary, during finishing.
   b. Foggers shall maintain humidity at height of 2 feet to 3 feet above surface of concrete.
   c. If necessary, apply evaporation retarder between finishing operations.
7. Repair mortar shall receive same finish as existing adjacent concrete surface.

D. Repair of Exposed Embedded Items in Concrete:

1. This provision addresses repair and rehabilitation of corroded metal items embedded in existing concrete and to other locations as expressly shown or indicated on the Drawings. Existing concrete damage by corrosion of embedded metal shall be repaired in accordance with this Section's Paragraph 3.2.B.
2. Preparation:
   a. Fully expose extent of metal corrosion within each embedded item by chipping to sound material. Where specifically shown or indicated on the Drawings, completely remove exposed metal item to extent shown or indicated.
   b. Prepare exposed reinforcing steel attached to or adjacent to embedded, corroded metal items in accordance with this Section's Paragraph 3.1.D.
   c. If existing concrete has been removed during chipping and repair of metal item, prepare repair area in accordance with this Section's Paragraph 3.1.C.
   d. Remove corrosion on embedded metal item and corrosion on exposed reinforcing steel by abrasive blasting to a white-metal finish.
3. Repair:
   a. Where no existing concrete has been removed or damaged adjacent to embedded metal item:
      1) On surface of embedded metal item, provide two coats of epoxy coating in accordance with coating manufacturer's recommendations.
         a) Color of First Coating: Red.
         b) Color of Second Coating: Gray.
      2) Before applying second coat, allow first coat of epoxy coating to fully cure in accordance with coating manufacturer's recommendations.
   b. Where areas of existing concrete have been removed or damaged adjacent to embedded metal item:
      1) Patch area of removed or damaged concrete in accordance with this Section's Paragraph 3.2.B.
      2) Provide on surface of embedded metal item two coats of epoxy coating in accordance with coating manufacturer's recommendations.
         a) Color of First Coat: Red.
         b) Color of second Coat: Gray.
      3) Before applying second coating, allow first coat of epoxy coating to fully cure in accordance with coating manufacturer's recommendations.

E. Extend existing control, construction, and expansion joints through concrete repairs.

F. For repairs of existing concrete damage, finish of repaired areas shall match the finish of existing adjacent concrete surface.

G. Expansion Joint Repair – Type A:

1. Provide materials and installation methods in accordance with sealant manufacturer recommendations and the Contract Documents.
2. Provide sealant and backer rod at moderate, reasonably stable, concrete temperature to optimize repair performance.
3. Comply with Section 07 92 00 - Joint Sealants.

H. Expansion Joint Repair – Type B:

1. Provide epoxy resin adhesive sealing system, in accordance with joint sealant system manufacturer's instructions and the Contract Documents, at locations shown or indicated on the Drawings:
   a. Existing sealant, backer rod, and joint filler material in acceptable condition are to remain in-place at existing joint locations to receive sealing system.

b. Concrete substrate on both sides of existing joint must be clean, dry, sound, and free of surface contaminants to not less than 10 inches wide strip centered on existing joint or greater when recommended by sealant manufacturer.
   1) Remove dust, laitance, grease, oils, curing compounds, form release agents, and foreign matter by sandblasting or other mechanical means acceptable to Engineer.
c. Mix epoxy resin adhesive and install hypalon sheeting in accordance with adhesive manufacturer's printed installation instructions and the Contract Documents.
d. Cleanup:
   1) Leave finished Work and work area in a neat, clean condition without evidence of spillovers on adjacent surfaces.
   2) Clean uncured epoxy resin adhesive with approved solvent appropriate for the application and area.
   3) Remove cured epoxy resin adhesive only by mechanical means.

I. Expansion Joint Repair – Type C (Joint Sealant System):
1. Installation of joint coating system shall comply with applicable material manufacturer's published recommendations and the Contract Documents.
2. Do not install concrete joint coating when substrate is in a rising-temperature mode.
3. Substrate, air, and coating material temperatures shall comply with applicable material manufacturer's recommendations and the Contract Documents.
4. Primer:
   a. Provide epoxy primer to concrete prior to installing final coating materials.
   b. Applied Thickness: 5 to 10 wet mils.
   c. Reapply coating as necessary to achieve pinhole/holiday-free surface
5. Comply with material manufacturer's recoat time. If recoat time(s) are exceeded, comply with material manufacturer's recommended procedures for surface abrasion, cleaning, and application of bonding agent.
6. Application of Coatings:
   a. Provide primer, base coat, scrim, and top coat in accordance with material manufacturer's requirements, as shown in the Drawings, and in accordance with other Contract Documents.
   b. Install primer (see item 4 above)
   c. Provide initial tack coat at thickens of 10 to 20 wet mils, to 6 inches on each side of joints to be coated.
   d. Push scrim material evenly into wet tack coat and allow to cure one to four hours, as recommended by coating manufacturer.
   e. Provide not less than thickness of 60 wet mils of top coat over scrim material.
   f. Protect and cure in accordance with material manufacturer's recommendations and the Contract Documents.
7. Should substrate temperatures be less than sealant system manufacturer's written recommended minimum temperature, comply with material manufacturer's modified procedures provide materials approved by Engineer and suitable for installation in cold conditions.

3.3 CURING

A. Curing of Repair Mortar:
1. Perform curing of repair mortar immediately after final finishing.
2. Perform curing by combination of covering repair Work with wet burlap and applying liquid membrane-forming curing compound.
3. Employ methods and sequence to maintain moisture for not less than seven days.

3.4 FIELD QUALITY CONTROL

A. Field Tests:

1. In-Situ Pull-Off Tests:
   a. Perform in-situ pull-off tests on repaired areas at locations indicated by Engineer.
      1) Perform not less than one pull-off test, in accordance with ASTM C1583, for each surface (wall, roof, floor, and other). In event of unacceptable pull-off test, repair the defective Work in accordance with the Contract Documents and perform additional test(s) at location(s) indicated by Engineer.
   b. Submit written results of testing, indicating: date of test, entity performing testing, personnel present during testing, time of test, location of test, pertinent results recorded, and other relevant observations.
   c. Criteria for Acceptance: Pull-off test will be deemed as passing (acceptable results) when failure occurs within the existing concrete substrate (cohesive concrete failure). If failure occurs at the joint surface with existing concrete (bond failure), within the repair material, or at connection to testing device, pull-out test will be deemed as passing (acceptable results) when the unit tensile stress acting on the core cross section at failure exceeds 300 psi. If failure occurs within the repair material, additional test samples of the repair material in the area of the test shall be taken for compressive testing to verify strength of repair material.
   d. Remedy all damage resulting from in-situ testing, in accordance with the Contract Documents.

B. Observations and Inspections:

1. Engineer will witness surface preparation, substrate moisture conditions, and installation of materials indicated in this Section. Such observations do not relieve Contractor from obligation to comply with the Contract Documents.
2. Owner-retained special inspector shall be present while material manufacturer's technical representatives are at the Site instructing Contractor's structural concrete repair personnel, Contractor's joint sealant system personnel, and installers in the use of the associated material(s).

C. Defective Work:

1. Defective Repair:
   a. Any and all repairs are defective Work when one or more of the following occurs:
      1) Pull-off test fails.
      2) When grout cube tests yield results less than 3500 psi for repair mortars in seven days.
      3) Repair is not properly finished and in accordance with specified tolerances.
   b. Promptly remove and remedy defective concrete repair Work in accordance with the Contract Documents.
2. Damaged Work:
   a. Before acceptance of the Work (following final inspection in accordance with the General Conditions and other Contract Documents), neatly repair damaged surfaces, corners of concrete, and finish.
   b. When performing surface remedial repairs, finish areas to smooth, dense watertight condition.
   c. Replace unsatisfactory concrete patching Work.
3. Corrective Work:
   a. If correction of defective Work (under this Section) is necessary, remove defective Work. Key area to be remedied, clean, and soak surface with water and patch with approved materials. Patch concrete to match existing adjacent concrete surfaces.

b. Clean surface cavities resulting from form ties, other holes, honeycomb spots, broken corners and edges, and other effects. Saturate with water and point with a mortar of patching material paste. Comply with patching material manufacturer's recommendations concerning placement, pot life, and curing.

c. Prepare pointing material not more than 30 minutes prior to use. Cure mortar patches properly. Carefully tool contraction and articulated joints in completed Work and keep them free of concrete. Where necessary, leave joint filler exposed for its full length with clean and true edges.

d. Tolerance deviations and other surface defects may also be corrected, when approved by Engineer, by grinding high areas of swales.

e. Where remedial work is unsatisfactory, completely remove such Work and replace with new Work in accordance with the Contract Documents.

4. Special inspection of remedial work is required. Special inspection will be performed after completion of surface preparation and during installation of remedial Work. Refer to Section 01 45 33 - Code Required Special Inspections and Procedures, for additional requirements.

5. Defective Joint Sealant System Work:

a. Any and all locations where joint sealant system has separated from concrete or exhibits cracking or tearing is defective Work.

b. Remove defective joint sealant system Work, clean the surface, and re-provide new joint sealant system materials.

c. Unless directed otherwise by Engineer, when area of defective joint sealant Work exceeds 25% of total area of joint sealant system Work provided, replace all joint sealant system Work in accordance with the Contract Documents.

D. Suppliers' Services:

1. Manufacturers' factory-trained technical representatives of concrete repair materials and joint sealant system shall be at the Site prior to and during first installation of the materials furnished under this Section to review surface preparation, surface moisture conditions and adhesion testing, and proposed installation methods. Joint sealant system manufacturer's representative shall also inspect the entire completed installation and submit, through Contractor, an affidavit of compliance certifying that installed materials comply with manufacturer written instructions and recommendations. Compensation for which is part of the lump sum price for such Work.

3.5 POST-CONSTRUCTION OBLIGATIONS

A. Warranty Inspection:

1. Perform warranty inspections during eleventh month after Substantial Completion of the Work of this Section.

2. For the inspections, Owner will dewater and reasonably clean water-bearing structures.

3. Operational constraints preclude removing all water-bearing structures from service simultaneously for warranty inspection. It is anticipated that 3 separate warranty inspections will be necessary due to operational constraints, each on different, non-consecutive days.

4. One warranty inspection of each joint sealed is required, unless defective Work is evident. When defective joint sealant Work is apparent, an additional warranty inspection of the repaired joint is required in the eleventh month after the defective joint sealant is remedied.

5. Contractor, joint sealant Subcontractor (if any), joint sealant system manufacturer's technical representative, and Owner, shall be present at each warranty inspection.

6. Contractor shall promptly remedy and replace defective Work, whether evident during the warranty inspection or otherwise, in accordance with the Contract Documents.

7. If contractor is unable or unavailable to remedy defective Work promptly when water-bearing structures are dewatered and cleaned for the warranty inspection, Owner may

place such structures back into service and Contractor will be responsible for appropriately dewatering and cleaning the structure to perform the necessary remedial Work.

8. Regarding remedy of defective joint sealant system Work, refer to this Section's Paragraph 3.4.C.

END OF SECTION

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SECTION 03 05 05
CONCRETE TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Contractor requirements for testing of concrete and grout.
2. Definition of Owner provided testing.
3. Acceptance criteria for concrete.
4. Materials and concrete testing as required to establish concrete mix design.
5. Testing of concrete during construction for compliance with Contract Documents.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 21 00 - Reinforcement.
2. Section 03 31 30 - Concrete, Materials and Proportioning.
3. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

1.2 RESPONSIBILITY AND PAYMENT

A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.

1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
3. Strength testing on concrete required by the Engineer or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re-removed.
6. Owner will pay for services defined in Paragraph 1.2A.1.
7. See Specification Section 01 42 00.

B. Duties and Authorities of Testing Agency/Service Provider:

1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.
3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
   a. All test reports to include exact location in the work at which batch represented by a test was deposited.
   b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
2. ASTM International (ASTM):
   a. ASTM Cement and Concrete Reference Laboratory (CCRL).
   b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   e. C94, Standard Specification for Ready-Mixed Concrete.
   f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   g. C172, Standard Practice for Sampling Freshly Mixed Concrete.
   h. C1019, Standard Test Method for Sampling and Testing Grout.
   i. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
   j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Qualifications:

1. Contractor's Testing Agency:
   a. Meeting requirements of ASTM E329 and ASTM C94.
   b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.

C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Concrete materials and concrete mix designs proposed for use.
      1) Include results of all testing performed to qualify materials and to establish mix designs.
      2) Place no concrete until approval of mix designs has been received in writing.
      3) Submittal for each concrete mix design to include:
         a) Sieve analysis and source of fine and coarse aggregates.
         b) Test for aggregate organic impurities.
         c) Proportioning of all materials.
         d) Type of cement with mill certificate for the cement.
         e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30.

f) Slump.
g) Brand, type and quantity of air entrainment and any other proposed admixtures.
h) Shrinkage test results.
i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
j) 28-day compression test results and any other data required by Specification Section 03 31 30 to establish concrete mix design.

2. Certifications:
   a. Testing Agency qualifications.
   b. Test results:
      1) Strength test results on concrete placed during construction including slump, air content, and concrete temperature.
      2) Strength test results on concrete core samples of in-place construction if required.
      3) Results of load testing in-place concrete construction when load testing is required.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

A. The following concrete testing will be performed by the Service Provider/Testing Agency procured by the Owner:

1. Concrete strength testing:
   a. Secure concrete samples in accordance with ASTM C172.
      1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
   b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
      1) Record any deviations from requirements on test report.
      2) Cylinder size: Per ASTM C31.
         a) 4 inches cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 inch.
         b) Use the same size cylinder for all tests for each concrete mix.
      3) Quantity:
         a) 6 inches diameter by 12 inches high: Four cylinders.
         b) 4 inches diameter by 8 inches high: Six cylinders.
   c. Field cure one cylinder for the seven day test.
      1) Laboratory cure the remaining.
   d. Test cylinders in accordance with ASTM C39.
      1) 6 inches diameter cylinders:
         a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
         b) Hold remaining cylinder in reserve.
      2) 4 inches diameter cylinders:
         a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
         b) Hold remaining cylinders in reserve.
   e. Strength test result:

1) Average of strengths of two, 6 inches diameter cylinders or three, 4 inches diameter cylinders from the same sample tested at 28 days.
2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
3) Should all cylinders in any test show any of above defects, discard entire test.

f. Frequency of tests:
1) Concrete topping, concrete fill and lean concrete: One strength test for each 30 CUYD of each type of concrete or fraction thereof placed.
2) All other concrete:
a) One strength test to be taken not less than once a day, nor less than once for each 50 cubic yards or fraction thereof placed in any one day.
b) Once for each 5000 square feet of slab or wall surface area placed each day
c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.

2. Slump testing:
a. Determine slump of concrete sample for each strength test.
1) Determine slump in accordance with ASTM C143.
b. If consistency of concrete appears to vary, the Engineer or Owner's Representative shall be authorized to require a slump test for each concrete truck.
1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.

3. Air content testing: Determine air content of concrete sample for each strength test in accordance with ASTM C231 , ASTM C173 , or ASTM C138.
4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

A. See Section 01 45 33.
1. Special Inspections listed are for the Contractor reference only and is not part of the Contract Documents.
2. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.

B. Formwork Special Inspections:
1. Shape, location, and dimensions.
a. Inspect in accordance with dimensions and details on Drawings.
b. Frequency: Inspect prior to each concrete pour.

C. Reinforcing Special Inspections:
1. Reinforcing size, spacing, lap length and concrete cover.
a. Inspect in accordance with Drawings and Specification.
b. Frequency: Inspect prior to each concrete pour.
2. Reinforcing adhesive anchoring system:
a. Inspect in accordance with ICC-ES report.
b. Frequency:
1) Inspect all adhesive anchors for the first 4 hours of installation.
2) Inspect approximately 25% of adhesive anchors thereafter.
3) Additional inspection will be required for different installer or if the quality of installation appears to vary.

3. Mechanical splices:
    a. Inspect in accordance with ICC-ES report.
    b. Frequency:
        1) Inspect all mechanical splices prior to placing concrete.
        2) Inspect approximately 25% of mechanical splices thereafter.
        3) Additional inspection will be required for different installer or if the quality of installation appears to vary.

D. Mixing, Placing, Jointing, and Curing Special Inspections:
1. Perform concrete tests per the requirements of this Specification Section.
2. Verification of proper mix design.
    a. Frequency: Periodically, prior to each concrete pour.
3. Proper concrete placement techniques.
    a. Inspect per requirements of Section 03 31 31.
    b. Frequency: During each concrete pour.
4. Proper curing temperature and techniques.
    a. Inspect per requirements of Section 03 31 31.
    b. Frequency: Periodically, but not less than every third day.
5. Joints:
    a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
    b. Frequency: Prior to each concrete pour.
6. Waterstops:
    a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
    b. Frequency:
        1) Prior to each concrete pour.

E. Anchorage to Concrete Special Inspection:
1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Engineer.
    a. Frequency: Per ICC-ES Report.
2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
    a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

A. To facilitate testing and inspection, perform the following:
1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 hours as required by ASTM C31.
3. Take samples at point of placement into concrete member.

B. Notify Contractor's Testing Agency sufficiently in advance of operations (minimum of 24 hours) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.

C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.

1. In this event, modifications may be required to assure that concrete work complies with requirements.
2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.

D. Dimensional Tolerances:

1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
   a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
   a. Repair or remove and replace if required.
5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
   a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

E. Appearance:

1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.

F. High Water-Cement Ratio:

1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.

G. Strength of Structure:

1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
   a. Low concrete strength:
      1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
         a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
         b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
         c) A strength test shall be the average of two, 6 inches diameter cylinders or three, 4 inches diameter cylinders from the same sample tested at 28 days.
      2) Acceptance:

a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:

(1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.

(2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 psi.

b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.

c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.

d. Curing time and procedure not meeting requirements of this Specification Section.

e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.

f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.

g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.

2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.

3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.

a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.

1) Such tests shall not be used as a basis for acceptance or rejection.

b. Core tests:

1) Where required, test cores will be obtained in accordance with ASTM C42.

a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 degrees F, relative humidity less than 60%) for seven days before test then test dry.

b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 hours and test wet.

c) Testing wet or dry to be determined by Engineer.

2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.

a) Location of cores shall be determined by Engineer so as to least impair strength of structure.

b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.

3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85% of specified strength and no single core is less than 75% of specified strength.

4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.

4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 27.

5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

SECTION 03 11 13
FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. CT-13, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 347R, Guide to Formwork for Concrete.

B. Qualifications:

1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
   a. Above qualifications apply to slabs and beams not cast on the ground.

C. Miscellaneous:

1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
2. Design requirements:
   a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
      1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
   b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. SCC: Self-Consolidating Concrete.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Manufacturer and type of proposed form ties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Forms for Surfaces Exposed to View:

1. Wood forms:
   a. 5/8 or 3/4 inches 5-ply structural plywood of concrete form grade.
   b. Built-in-place or prefabricated type panel.
2. Metal forms:
   a. Metal forms may be used except for aluminum in contact with concrete.
   b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:

1. Wood or metal sufficiently tight to prevent leakage.
2. Do not use aluminum forms.

2.2 ACCESSORIES

A. Form Ties:

1. Commercially fabricated for use in form construction.
   a. Field fabricated ties are unacceptable.
2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
3. Embedded portion of ties to be not less than 1-1/2 inches from face of concrete after ends have been removed.
4. Cone size:
   a. 3/4 inches minimum diameter cones on both ends.
   b. Depth of cone not to exceed the concrete reinforcing cover.
5. Provide ties with built-in waterstops in all walls that will be in contact with below grade soil.

B. Form Release Material:

1. If project contains self-consolidating concrete, provide reactive, vegetable based product, not barrier type.

C. Void Forms:

1. Constructed from double faced corrugated cardboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.
2. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:

1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
   a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Apply form release material to minimize bugholes and pinholes. Follow manufacturer's printed installation instructions specific to the form facing material.

C. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.

1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 feet apart.

D. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:

1. Conform to ACI 117.
2. Variation from plumb:
   a. In lines and surfaces of columns, piers, walls, and in risers.
      1) Maximum in any 10 feet of height: 1/4 inches.
      2) Maximum for entire height: 1/2 inches.
   b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
      1) Maximum in any 20 feet length: 1/4 inches.
      2) Maximum for entire length: 1/2 inches.
3. Variation from level or from grades specified:
   a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
      1) Maximum in any 10 feet of length: 1/4 inches.
      2) Maximum in any bay or in any 20 feet length: 3/8 inches.
      3) Maximum for entire length: 3/4 inches.
   b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
      1) Maximum in any bay or in 20 feet length: 1/4 inches.
      2) Maximum for entire length: 1/2 inches.
4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
   a. Maximum in any bay: 1/2 inches.
   b. Maximum in any 20 feet of length: 1/2 inches.
   c. Maximum for entire length: 1 inch.
5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 inches.
6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 inches.
7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 inches, +1/2 inches.
8. Footings and foundations:
   a. Variations in concrete dimensions in plan: -1/2 inches, +2 inches.
   b. Misplacement or eccentricity:
      1) 2% of footing width in direction of misplacement but not more than 2 inches.
   c. Thickness:
      1) Decrease in specified thickness: 5%.

2) Increase in specified thickness: No limit except that which may interfere with other construction.

9. Variation in steps:
   a. In a flight of stairs:
      1) Rise: +1/8 inches.
      2) Tread: +1/4 inches.
   b. In consecutive steps:
      1) Rise: +1/16 inches.
      2) Tread: +1/8 inches.
10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and benchmarks to be used for reference purposes to check tolerances.
11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 inches chamfer strips in exposed to view corners of forms to produce 3/4 inches wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 inch.
   1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
   2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.

F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 feet wide.
   1. Brace and tie formwork to maintain correct position and shape of members.

G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
   1. Securely brace forms against lateral deflection.
   2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.

   1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength.

   1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 FIELD QUALITY CONTROL

A. Special Inspection:

   1. See Section 01 45 33.
   2. See Section 03 05 05.

END OF SECTION

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SECTION 03 15 19
ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for anchorages in concrete, including cast-in-place anchor bolts, anchor rods, reinforcing anchorage adhesive, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
2. Delegated design requirements for concrete anchors not expressly shown or indicated on the Drawings or elsewhere in the Contract Documents, including, but not limited to, anchorages in concrete for the following structural and nonstructural components:
   a. Structural members and accessories.
   b. Metal, wood, and plastic fabrications.
   c. Architectural Work, including building components, finishes, specials, facility equipment and conveying equipment, furnishings, and special construction Work.
   d. Mechanical and electrical Work, including process-mechanical Work, site and infrastructure Work, electrical Work, communications Work, electronic safety and security systems Work, and others.
   e. Fire suppression, plumbing, and HVAC Work.
   f. Other components requiring anchorages to concrete.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 01 35 73 - Delegated Design Procedures.
2. Section 01 81 10 - Wind and Seismic Criteria
3. Section 03 05 05 - Concrete Testing and Inspection.
4. Section 40 05 07 - Pipe Support Systems.

1.2 REFERENCES

A. Definitions and Terminology:

1. This provision presents definitions and terminology, which have the meanings indicated in this provision, applied to the singular or plural thereof, and without regard to use of initial capital letters.
   a. Adhesive Anchors:
      1) Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
      2) Includes anchors using acrylics, epoxy and other similar adhesives.
   b. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.
   c. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.
   d. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.
   e. Galvanizing: Hot-dip galvanizing in accordance with ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 ounces of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by reference standard.
   f. Hardware: As defined in ASTM A153.
   g. MPII: Manufacturer’s printed installation instructions.
   h. Mechanical Anchors:
      1) Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.

2) Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
3) Drop-in anchors and other similar non-ICC ES approved anchors are unacceptable.

i. Post-Installed Anchor: Adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

B. Reference Standards:

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete and Commentary.
   b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
   a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
3. American Institute of Steel Construction (AISC):
   a. 303, Code of Standard Practice for Steel Buildings and Bridges.
   b. 355.2, Seismic Testing of Post-Installed Concrete and Masonry Anchors in Cracked Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
4. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
   g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   i. F436, Standard Specification for Hardened Steel Washers.
   j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   k. F594, Standard Specification for Stainless Steel Nuts.
   l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
   m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
5. International Code Council Evaluation Service (ICC-ES):
   a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. For post-installed anchors and other anchorages installed in existing concrete, comply with Section 01 73 29 - Cutting and Patching.
2. Comply with coordination requirements in Section 01 35 73 - Delegated Design Procedures.

B. Pre-Design Conference:

1. Pre-design conference for anchorages to concrete (where such anchorages are delegated design Work) is not required.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Code-required Special Instructions:
   a. Special Inspection is required in accordance with the building code for all concrete anchorages.
   b. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
   c. See the “Field Quality Control” Article in “Part 3 – Execution” of this Section for additional requirements.

B. Qualifications:

1. Delegated Design Professional:
   a. Delegated design professional’s qualifications and responsibilities shall be in accordance with Section 01 35 73 - Delegated Design Procedures.
2. Installer:
   a. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
   b. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Submit schedule (table or listing) of types, sizes (diameter, length, embedment length), material, finish, and proposed manufacturers of anchorages to concrete to be provided. Apportion by Project-specific application (for example, “Anchorages for cooling water pumps in basement”) and indicate where anchorages are fully-designed by Engineer and those for which final design was prepared by delegated design professional.
   b. Engineer’s approval of such Shop Drawing will be only for anchorages fully designed by Engineer. For anchorages for which final design is by delegated design professional, include on such Shop Drawing delegated design professional’s approval stamp.
2. Product Data: Submit as Action Submittals product data for anchorages to concrete fully designed by Engineer. For anchorages to concrete for which final design is by delegated design professional, submit as Informational Submittals bearing approval stamp of delegated design professional.
   a. Manufacturer’s express, written acknowledgement that proposed items comply with referenced standards indicated in this Section and, as applicable, by delegated design professional.
   b. Manufacturer published data and information for each anchor.
      1) Clearly indicate items that are proposed for the Work. Neatly strike out or obscure materials and products not proposed.
   c. Manufacturer's published installation instructions and instructions for code-required special inspections and tests.
   d. Post-Installed Anchors: In addition, submit for each post-installed anchor system current ICC-ES report, indicating the following:
      1) Manufacturer’s certification that anchors comply with requirements indicated in the Contract Documents.

2) Performance data indicating that anchor is approved by its manufacturer for use in cracked concrete.
3) Seismic design categories for which anchor system is approved by ICC-ES report.

e. Anchorage layout drawings and details:
1) Drawings showing location, configuration, spacing and edge distance.

3. Delegated Design Professional's Instruments of Service Submittals: Submit, in accordance with this Section and Section 01 35 73 – Delegated Design Procedures, for each anchorage to concrete for which final design is by delegated design professional:
a. Certification of compliance, in accordance with Section 01 35 73 – Delegated Design Procedures. Indicate design tension and shear loads used for anchor design.
b. Delegated design professional's drawings.
c. Delegated design professional's specifications, if any, when prepared by delegated design professional.
d. Post-Installed Anchors (for which final design is by delegated design professional): Submittal shall also include the following for post-installed anchors for which final design was by delegated design professional:
1) Show diameter, embedment depth and edge distance of each anchor.
2) Indicate compliance with ACI 318 Chapter 17
3) Type of post-installed anchor system used.
a) Provide manufacturer's ICC-ES report for the following:
(1) Mechanical anchorage per ICC-ES AC193.
(2) Adhesive anchorage per ICC-ES AC308.

4. Samples:
a. Submit representative Samples of anchorages to concrete, when requested by Engineer. Engineer's approval of Samples will be for type and finish only.

B. Informational Submittals: Submit the following:
1. Shop Drawings and Product Data Approved by Delegated Design Professional:
a. Submit with delegated design professional's approval stamp those Shop Drawings and product data Submittals indicated in this Article but for which final design was performed by delegated design professional.
2. Calculations by Delegated Design Professional:
a. Submit sealed and signed calculations for sizing and determining embedment length of anchorages to concrete not fully designed by Engineer.
b. Post-Installed Anchors Designed by Delegated Design Professional: In addition, also submit design calculations:
1) Indicate design load to each anchor.
2) When design load is not indicated on the Drawings, include calculations to develop anchor forces based on performance and design criteria indicated in this Section.
3. Supplier's Instructions:
a. Submit manufacturer's published instructions for installation.
4. Field Quality Control Submittals:
a. Submit written results of required field quality control activities indicated in this Section.
5. Reports of Supplier's Visits to Site:
a. Submit each written report of visit to the Site by Supplier's factory trained representative and delegated design professional. For each, indicate date and time of visit, purpose of visit, observations made, decisions made, problems encountered, and other pertinent information.
6. Qualifications Statements:
a. Delegated design professional.

b. Each installer.

PART 2 - PRODUCTS

2.1 MATERIALS – ALL ANCHORAGES

A. Materials – General:

1. This Article applies to all anchorages to concrete, regardless of whether fully designed by Engineer or delegated design professional. Requirements for delegated designs are in the following Article.
2. Additional requirements for anchorages fully designed by Engineer are indicated in the Article following requirements for delegated design anchorages.
3. For structural applications, do not use powder actuated fasteners and other types of bolts or fasteners not specified in this Section unless approved by Engineer or otherwise required by the Contract Documents.

B. Description:

1. Provide anchorages to concrete, of the types shown or indicated, to secure to concrete materials, equipment, and appurtenances installed as part of the Work.
2. Locations where anchorages are required are generally shown or indicated on the Drawings. Where not shown or indicated on the Drawings provide anchorages or the types required for materials, equipment, and systems where such materials, equipment, and systems are shown on the Drawings.
3. Anchorages required include those for materials, equipment, and systems shown on the structural Drawings and Drawing other than the structural Drawings.
4. Design loads for concrete anchorages are shown or indicated on the Drawings for anchorages where design responsibility is delegated to Contractor's delegated design professional. For such anchorages, embedment depths are not shown or indicated.

C. Cast-in-place Concrete Anchors:

1. Buildings, non-building structures, and equipment, unless otherwise specified:
   a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized or non-galvanized threaded rods.
   b. ASTM A307, Grade A for galvanized headed bolts.
2. All other cast-in-place concrete anchors:
   a. Stainless steel with matching nut and washer.
   b. Submerged application: ASTM F593, Type 316, minimum yield strength of 45,000 psi.
   c. Non-submerged application: ASTM F593, Type 304 or Type 316, minimum yield strength of 45,000 psi.

D. Post-Installed Mechanical and Adhesive Concrete Anchors:

1. Submerged application: ASTM F593, Type 316, minimum yield strength of 45,000 psi with matching nut and washer.
2. Non-submerged application: ASTM F593, Type 304 or Type 316, minimum yield strength of 45,000 psi with matching nut and washer.
3. Post-installed anchors and related materials shall be listed by ICC-ES or Engineer-approved equivalent.

E. Reinforcing: Comply with Section 03 21 00 - Reinforcement.

F. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

G. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

H. Washers:

1. ASTM F436 unless indicated otherwise, finish to match bolt.
2. When stainless steel anchorage is provided for cast-in-place anchorages, provide washers of the same material and alloy as in the associated anchorage.
3. Plate washers: Minimum 1/2 inch thick fabricated ASTM A36 square plates as required.
4. Comply with manufacturer's written instructions for all post-installed anchorages.

I. Nuts:

1. ASTM A563 for cast-in-place anchorages.
2. When stainless steel anchorages are provided for cast-in-place anchorages, nuts shall comply with ASTM F594 and shall match material and alloy of the associated anchorage.
3. Follow manufacturer's requirements if using post-installed anchorage.

J. Galvanizing Repair Paint:

1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92 percent in dry film.
4. Products and Manufacturers: "ZRC Cold Galvanizing", by ZRC; or "High Performance Zinc Spray", by Clearco; or equal.

K. Dissimilar Materials Protection: Comply with Section 09 96 00 - High-Performance Industrial Coatings.

2.2 DELEGATED DESIGN ANCHORAGES TO CONCRETE

A. Manufacturers:

1. Post-installed anchor systems for indicated manufacturers are acceptable only when a current ICC-ES evaluation report is furnished as a Submittal and the subject anchorage system is approved by delegated design professional.
   a. Hilti.
   b. Dewalt.
   c. Simpson Strong-Tie.
   d. Or equal.

B. Description: Perform delegated design for anchorages when one or more of the following applies:

1. Design load for concrete anchorage is shown or indicated on the Drawings and anchorage embedment depth is not shown or indicated.
2. When specifically required by the Contract Documents.
3. When an anchorage is necessary but is not shown or indicated on the Drawings.
4. Anchorages shown on the Drawings other than the structural Drawings.

C. Performance and Design Criteria for Delegated Design Anchorages:

1. Determine design loads, including wind and seismic loads, in accordance with applicable building code and other Laws and Regulations.
2. For anchorage of equipment and non-structural components, use actual dead load and operating loads obtained by Contractor or delegated design professional from manufacturer. Design loads shall include operating conditions when equipment or element of the Work is in operation, dynamic loads, and other loads as appropriate or required by the building code or other Laws or Regulations.
3. Additional Support Requirements for Piping and Utilities: Comply with applicable Specifications.
4. Design assuming cracked concrete.

2.3 ANCHORAGES FULLY DESIGNED BY ENGINEER

A. When size, length, and details of anchorage are shown or indicated on the structural Drawings, such anchorages are considered as fully designed by Engineer and delegated design of such anchorage is not required.

B. Manufacturers:

1. For post-installed anchor systems regardless of whether proposed manufacturer is indicated below, furnish as Submittal current evaluation agency report and anchor system is certified by ICC-ES for cracked concrete conditions.
2. Mechanical Anchors:
   a. Hilti:
      1) Kwik Bolt TZ (ICC-ES ESR-1917).
   b. Dewalt:
      1) Power-Stud+ SD1 (ICC-ES ESR-2818).
   c. Simpson Strong-Tie:
      1) Strong-Bolt 2 (ICC-ES ESR-3037).
   d. Or equal.
3. Adhesive Anchors for Concrete:
   a. Hilti:
      1) HIT RE 500 V3 (ICC ESR-3814).
   b. Dewalt:
      1) PURE110+ (ICC-ES ESR-3298).
   c. Simpson Strong-Tie:
      1) SET-3G (ICC ES 4057)
   d. Or equal.
4. Screw Anchors for Concrete:
   a. Hilti:
      1) Kwik HUS-EZ Screw (ICC-ES ESR-3027).
   b. Dewalt:
      1) Screw-Bolt+ (ICC-ES ESR-3889).
   c. Simpson Strong-Tie:
      1) Titen HD (ICC-ES ESR-2713).
   d. Or equal.
5. Requests, if any, for Engineer's approval of "or-equals" or substitutes shall indicate proposed anchor has at least the same tension and shear strength as the associated anchorage products indicated by name in this Article.

PART 3 - EXECUTION

3.1 PREPARATION

A. For cast-in-place concrete anchorages, allow adequate time for proper installation, inspection, and observation prior to placing concrete.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorages will be installed.

1. Notify Engineer of conditions detrimental to proper and timely completion of the Work.
2. Do not proceed with the Work until unsatisfactory conditions are properly remedied.

3.2 INSTALLATION

A. Installation Requirements - General:

1. Install items in accordance with the Contract Documents, manufacturer's written instructions, and Laws and Regulations. Where such requirements conflict, obtain interpretation or clarification from Engineer prior to commencing the associated Work.
2. Perform the following unless shown or indicated otherwise:
   a. Provide stainless steel anchorages for connecting aluminum and steel members to concrete and masonry. Provide dissimilar materials protection in accordance with Section 09 96 00 – High-Performance Industrial Coatings.
   b. Provide washers for all anchorages.
   c. Where exposed, extend threaded anchorage a maximum of 0.75 inch and a minimum of 0.5 inch above top of fully-engaged nut. If anchorage is cut off to required maximum height, dress the threads to allow nuts to be removed without damage to nuts.
3. Tightening of nuts: Do the following after nuts are snug-tightened down:
   a. Upset anchorage threads to prevent nuts from backing off. Provide double nut or lock nut in lieu of upset threads for items that may require future removal.
   b. For cast-in-place anchorages (excluding post-installed anchorages), tighten nuts an additional 1/8 turn beyond snug tight to prevent nuts from backing off.
   c. When two nuts are used per concrete anchor above the base plate, tighten top nut an additional 1/8 turn to "lock" the two nuts together.
   d. For post-installed anchorages, comply with MPII.
4. Secure architectural components to avoid aesthetic distortion and to avoid overstressing fasteners from expansion, contraction, or installation.

B. Cast-in-Place Anchorages:
1. Provide where anchor rods or anchor bolts are indicated on the Drawings, unless another anchor type is approved by Engineer.
2. Provide concrete anchorages as shown on the Drawings or as required to secure the Work to concrete.
3. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
4. Tack welding of anchorage is prohibited.
5. Chase threads as required and coat projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
6. Anchorage location Tolerance: in accordance with AISC 303.
7. Provide steel or durable wood templates for all column and equipment anchorages. Place templates above top of concrete; do not impede proper concrete placement and consolidation.

C. Mechanical Anchorages:
1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
2. Do not use where subjected to vibration.
3. May be used in overhead applications.
4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.

D. Post-installed Anchorages:
1. For post-installed anchors, comply with MPII regarding hole diameter and depth required to fully develop the tensile strength of anchor or reinforcing bar.
2. Use hammer drills to create holes.
3. Properly clean out holes in accordance with the associated ICC-ES report using non-metallic, fiber bristle brush and compressed air, or as otherwise necessary to remove all loose material from each hole prior to installing anchor in the presence of Special Inspector.
4. Adhesive Anchorages:

a. Provide only where specifically indicated on the Drawings or when approved for use by Engineer.
b. May be provided where subjected to vibration or at buried or submerged locations.
c. Do not install for overhead applications or sustained tension loading conditions such as utility hangers.
d. Install adhesive anchors in concrete aged not less than 28 days.

E. Finishes:
1. Coat aluminum surfaces in contact with dissimilar materials in accordance with Section 09 96 00 – High-Performance Industrial Coatings.
2. Repair of damaged galvanized surfaces:
a. Prepare damaged surfaces by abrasive blasting or power sanding.
b. Repair damaged galvanized surfaces in accordance with ASTM A780.
c. Apply galvanizing repair paint to not less than 6 mils dry film thickness in accordance with galvanizing repair material manufacturer's instructions and ASTM A780.

F. Ensure that embedded items are protected from damage and are not filled in with concrete or related materials.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
1. Special Inspections: Comply with Section 01 45 33 - Code-Required Special Inspections and Procedures.
2. Comply with Section 03 05 05 - Concrete Testing and Inspection.
3. Tests and inspections of anchorages shall comply with ACI 355.2 and/or ACI 355.4 as applicable.
4. Owner reserves the right to inspect and test completed anchorages at a minimum of 25 to 50 percent of provided anchorages.

B. Supplier’s services:
1. Post-installed anchor manufacturer’s representative shall demonstrate and observe the proper installation procedures for the post-installed anchors.

C. Defective Work:
1. Anchorages that do not successfully pass required field tests and inspections or that are otherwise deemed defective by Engineer shall be remedied, in accordance with the Contract Documents, at no cost to Owner.

3.4 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings when specified in Specification Section 09 96 00.

END OF SECTION

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SECTION 03 21 00
REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforcing bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. SP 66, ACI Detailing Manual.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   d. 318, Building Code Requirements for Structural Concrete.
   e. 350, Code Requirements for Environmental Engineering Concrete Structures.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
   f. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3. Concrete Reinforcing Steel Institute (CRSI):
   a. Manual of Standard Practice.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Mill certificates for all reinforcing.
   d. Manufacturer and type of proprietary reinforcing mechanical splices.
2. Qualifications of welding operators, welding processes and procedures.
3. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
4. Sufficient reinforcing details to permit installation of reinforcing.
5. Reinforcing details in accordance with ACI SP 66 and ACI 315.
6. Locations where proprietary reinforcing mechanical splices are required or proposed for use.

7. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
    a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
    b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Reinforcing adhesive anchors:
        a. See Specification Section 03 15 19.
    2. Reinforcing mechanical splices:
        a. Lenton Rebar Splicing by Erico, Inc.
        b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
        c. Bar-Grip Systems by Barsplice Products, Inc.

2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.

C. Welded Wire Reinforcement: ASTM A1064.

D. Smooth Dowel Bars:
    1. Water containing structures: ASTM A276, Type 304.
    2. All other locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 inch.

E. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125% of the yield strength of the reinforcing bars being spliced.

F. Headed Deformed Bars:
    1. ASTM A970, Class B.

G. Reinforcing Adhesive Anchors:
    1. See Specification 03 15 19.

2.3 ACCESSORIES

A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
    1. Metal fabrications with plastic-coated tips in contact with forms.
        a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
    2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
        a. 100% non-metallic, non-corrosive.
        b. Required for all walls and elevated construction exposed to liquid containing structures.

2.4 FABRICATION

A. Tolerances:

1. Conforms to ACI 117, expect as modified herein.
2. Sheared lengths: +1 inches.
3. Overall dimensions of stirrups, ties and spirals: +1/2 inches.
4. All other bends: +0 inches, -1/2 inches.

B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship reinforcing to jobsite with attached plastic or metal tags.

1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:

1. Conform to ACI 117, except as modified herein.
2. Reinforcing placement:
   a. Clear distance to formed surfaces: +1/4 inches.
   b. Minimum spacing between bars: -1/4 inches.
   c. Top bars in slabs and beams:
      1) Members 8 inches deep or less: +1/4 inches.
      2) Members between 8 inches and 2 feet deep: -1/4 inches, +1/2 inches.
      3) Members more than 2 feet deep: -1/4 inches, +1 inches.
   d. Crosswise of members: Spaced evenly within +1 inches.
   e. Lengthwise of members: +2 inches.
3. Minimum clear distances between reinforcing bars:
   a. Beams, walls and slabs: Distance equal to bar diameter or 1 inch, whichever is greater.
   b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 inches, whichever is greater.
   c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:

1. For reinforcing: Class B splice meeting the requirements of ACI 318.
2. For welded wire reinforcement:
   a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 x development length nor less than 6 inches.
   b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.
   a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding:

1. Welding reinforcing is not permitted.

E. Placing Reinforcing:

1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
3. Reinforcing support:
   a. Uncoated reinforcing:
      1) Support reinforcing and fasten together to prevent displacement by construction operations.
         a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
         b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
         c) Reinforcement shown on the Contract Documents may not be repositioned for use as support for reinforcement. Additional drop bars may be provided for support of reinforcing,
      2) Reinforcing supported on ground:
         a) Slab on grade and other members with only one mat of reinforcing:
            (1) Provide metal bar supports with bottom plate.
            (2) Do not use concrete blocks to support slab-on-grade reinforcing.
         b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
      3) Reinforcing supported on formwork:
         a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
         b) All other formed surfaces:
            (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
            (2) Only tips in contact with the forms need to be plastic coated.
4. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 inch.
   a. Place spacer bars at 3 feet maximum centers to maintain the required 1 inch clear distance between layers.
5. Extend reinforcement to within 2 inches of concrete perimeter edges.
   a. If perimeter edge is formed by earth, extend reinforcement to within 3 inches of the edge.
6. To assure proper placement, furnish templates for all column vertical bars and dowels.
7. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.
   a. Do not bend reinforcing by means of heat.
8. Do not tack weld reinforcing.
9. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
   a. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:

1. Notify Engineer whenever the specified clearances between bars cannot be met.
2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
5. No cutting of reinforcing shall be done without written approval of Engineer.

B. Special Inspection:

1. See Section 01 45 33.
2. See Section 03 05 05.
3. Special Inspection is required for:
   a. Reinforcing size, spacing, lap length and concrete cover.
      1) Inspect in accordance with Drawings and Specification.
      2) Frequency: Inspect prior to each concrete pour.
   b. Reinforcing adhesive anchoring system:
      1) Inspect in accordance with ICC-ES report.
      2) Frequency:
         a) Inspect all adhesive anchors for the first 4 HRs of installation.
         b) Inspect approximately 25% of adhesive anchors thereafter.
         c) Additional inspection will be required for different installer or if the quality of installation appears to vary.
   c. Mechanical splices.
      1) Inspect in accordance with ICC-ES report.
      2) Frequency:
         a) Inspect all mechanical splices prior to placing concrete.
         b) Inspect approximately 25% of mechanical splices thereafter.
         c) Additional inspection will be required for different installer or if the quality of installation appears to vary.

END OF SECTION

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SECTION 03 31 30
CONCRETE MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for concrete materials, including:
   a. Materials, including various types of grout, admixtures, cement, sand, aggregate, and other materials.
   b. Concrete strength and proportioning, including design mixes for:
      1) Normal weight concrete.
      2) Grout.

B. Scope:

1. Unless shown or indicated otherwise in the Contract Documents, concrete Work shall comply with:
   a. ACI 301.
   b. Laws and Regulations, including applicable building code.
2. In this Section, material is apportioned into the following grouting types:
   a. Base plates for columns and equipment.
   b. As otherwise shown or indicated in the Contract Documents.
3. This Section addresses materials for concrete. Other Specifications sections present other requirements for complete concrete Work, including, but not necessarily limited to:
   a. Section 03 05 05 - Concrete Testing and Inspection.
   b. Section 03 11 13 - Formwork.
   c. Section 03 21 00 - Reinforcement.
   d. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   e. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   f. Others as indicated in the Contract Documents.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 03 21 00 - Reinforcement.
4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.

1.2 REFERENCES

A. Abbreviations and Terminology:

1. Abbreviations: The following abbreviations are used in this Section:
   a. “AAR” means deleterious “alkali-aggregate reaction”, resulting from either alkali-silica reactive (ASR) or alkali-carbonate reactive (ACR) aggregates.
   b. “SCM” means “supplementary cementitious materials”, with the meaning indicated below.
   c. “CLSM” means controlled low strength material in accordance with requirements of this Section.
2. Terminology: Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meanings indicated below:
   a. “Supplementary cementitious materials” (SCM) means fly ash, silica fume, and GGBFS.

b. “Water-bearing concrete” is concrete surface to be in contact (whether continuously or intermittently) with water, process liquid, or slurries during intended operation of the facility, including, but not limited to, concrete tanks, channels, wet wells, distribution chambers, and secondary containment structures.

c. Independent Laboratory:

1) Testing shall be performed by an independent laboratory complying with requirements of the generally recognized accrediting entity for the jurisdiction where the Site is located.

2) Testing laboratory shall obtain all concrete samples and waterproofing product samples from the manufacturer of the associated product or material.

B. Reference Standards:

1. American Concrete Institute (ACI):

a. CT-13, Concrete Terminology.

b. 117, Specification for Tolerances for Concrete Construction and Materials.

c. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

d. 212.3R, Chemical Admixtures for Concrete.

e. 232.2R, Use of Fly Ash in Concrete.

f. 301, Specifications for Structural Concrete for Buildings.

2. ASTM International (ASTM):

a. C33, Standard Specification for Concrete Aggregates.

b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

c. C94/C94M, Standard Specification for Ready-Mixed Concrete.

d. C125, Terminology Relating to Concrete and Concrete Aggregates.

e. C150, Standard Specification for Portland Cement.

f. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.

g. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

h. C260, Standard Specification for Air-Entraining Admixtures for Concrete.

i. C494, Standard Specification for Chemical Admixtures for Concrete.

j. C595, Standard Specification for Blended Hydraulic Cements.

k. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

l. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

m. C1116, Standard Specification for Fiber-Reinforced Concrete.

n. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.

o. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).

p. C1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

q. C1778, Standard Guide for Reducing Risk of Deleterious Alkali-Aggregate Reaction in Concrete.

3. Steel Deck Institute (SDI):

a. Design Manual for Composite Decks, Form Decks and Roof Decks.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Schedule (table) of concrete materials proposed, listed by each specified grouping of concrete Work, including, but not limited to, aggregates, sand, cement (by type), SCM, admixtures, synthetic fibers, grouts, and other materials. For each separate material and product, indicate manufacturer and type of material.
   b. Mix Designs:
      1) Proposed mix design for each concrete grouping required. For each, indicate concrete designation (type) indicated in the Contract Documents, proposed materials and proportioning, and intended special uses, such as concrete intended for placement in cold weather or warm weather, concrete to be placed by pumping, concrete intended for specific locations in the Work, and others.
      2) Engineer's approval of mix design Shop Drawing is only for limited purposes indicated in the Contract Documents, including the General Conditions, and in no way reduces or mitigates Contractor's responsibility for construction means, methods, techniques, procedures, and sequences.
2. Product Data:
   a. Written affidavit stating materials proposed comply with requirements of reference standards indicated in this Section and, where applicable, compliance with standard specifications for highway and bridge construction in the jurisdiction of the Site. Clearly indicate specific reference standards applicable to each specific material.
   b. For aggregate and sand, indicate source (quarry) and gradation of materials proposed for use. Indicate the specific concrete mix design(s) proposed for each.
   c. For cement and SCM, indicate material source and submit manufacturer's technical data (except safety data sheets).
   d. For each proposed admixture and type of grout material (including non-shrink grouts, epoxy grout, and grout cure/seal compound), submit manufacturer's published technical data (except safety data sheets).

B. Informational Submittals: Submit the following:

1. Certifications: Submit concurrent with, but separate from, associated Shop Drawings and product data Submittals:
   a. Certification of standard deviation, in units of pounds per square inch, for ready mix plant furnishing concrete.
   b. SCM: Certification that SCM complies with quality requirements of this Section, and SCM Supplier's certified test reports of SCM delivered to concrete Supplier.
   c. ASTM C33: Certification that class of coarse aggregate complies with ASTM C33 for type and location of concrete Work.
   d. Aggregate:
      1) Certification of aggregate gradation.
      2) Certification of coarse aggregate impurities relative to alkali-aggregate reactivity in accordance with ASTM C1778.
   e. Certification of shrinkage test results.
2. Test Reports:
   a. Cement and SCM mill certificates for all materials to be supplied.
   b. Test results for AAR impurities of coarse aggregates within proposed mixes, in accordance with ASTM standards cited in this Section.
3. Supplier's Instructions: Submit concurrent with, but separate from, associated product data Submittals:

a. Manufacturer's written instructions on proper storage, handling, mixing, and use of materials furnished.

1.4 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:

1. Admixtures:
   a. Store admixtures in manner that avoids contamination, evaporation, and damage.
   b. For admixtures used in form of suspensions or non-stable solutions, perform agitating as recommended by manufacturer to ensure uniform distribution of ingredients.
   c. Protect liquid admixtures from freezing and temperature changes that adversely affect admixture characteristics and performance.
2. Cement and SCM:
   a. Store cement and SCM in containers in weathertight space that prevent contamination with moisture and other contaminants.
3. Aggregates:
   a. Store and access aggregates in manner avoiding excessive segregation and preventing contamination with other materials and other sizes of like aggregate.
   b. Do not use frozen or partially frozen aggregate.
4. Sand: Allow natural sand to drain until sand has relatively uniform moisture content, prior to use.
5. If stockpiled materials contact the ground, unless such materials are stored on a clean, firm, reasonably impervious surface such as concrete or asphalt paving, do not use in the concrete Work bottom six inches of stockpiled materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

1. Provide ASTM C150, Type IL cement, unless otherwise required by the Contract Documents.
2. Cement type provided shall match cement type used in associated approved mix design.

B. SCM:

1. Fly Ash:
   a. ASTM C618, Class F.
   b. Non-staining.
   c. Appropriate for providing hardened concrete of uniform, light-gray color.
   d. Compatible with all other concrete ingredients. Fly ash shall have no deleterious effect on hardened concrete Work.
   e. Evaluate and use in accordance with ACI 232.2R.
2. SCM type used shall match SCM type used in associated approved mix design.

C. Admixtures:

1. Admixtures – General:
   a. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in mix design approved by Engineer.
   b. Provide admixtures certified by manufacturers as compatible with other admixtures proposed.
2. Air Entraining Admixtures: Comply with ASTM C260.
3. Water Reducing Admixtures:

a. Provide water-reducing admixtures in all concrete mixes to provide and maintain required water-to-cement ratio without additional cement.
b. Water Reducing, Retarding and Accelerating: Comply with ASTM C494 Types A through E, and ACI 212.3R.
c. High Range Water Reducers (Superplasticizers):
1) Required for pumped concrete.
2) Comply with ASTM C494 Types F and G.

4. Hydration Stabilizer:
a. Comply with ASTM C494 Type D.
5. Admixture Chlorides – General:
a. Provide chloride-free admixtures.
b. Do not use calcium chloride.

D. Water:
1. Potable in accordance with Laws and Regulations.
2. Clean and free from deleterious substances.
3. Free of oils, acids, and organic matter. Comply with ASTM C1602.

E. Aggregates for Normal Weight Concrete:
1. Comply with ASTM C33.
2. Fine aggregates and coarse aggregates are separate ingredients.
3. Provide aggregates acceptable for bridge construction in accordance with the third-party standard specifications indicated below in this provision.
4. Blended aggregates are unacceptable
5. Coarse Aggregate:
a. Material shall be well-graded, washed aggregate, free of organic material, .
b. Gradation: In accordance with Table 03 31 30-A in this section's "Mixes" Article.
6. Alkali-Reactive Aggregates:
a. Aggregates that may be deleteriously reactive, when combined with alkalis in cement, are unacceptable.
b. Evaluate proposed aggregates for potential deleterious alkali-aggregate reaction in concrete in accordance with ASTM C1778.
1) Submit to Engineer results of source quality control testing for alkali-aggregate reactivity presenting the following:
a) Analysis and classification of aggregates in accordance with ASTM C1778
b) Results of source quality control analysis of aggregates.
c) Include the flow from Figure 1 of ASTM C 1778 indicating test results sequence.
d) Field performance history alone shall not be submitted to document acceptable aggregate performance.
e) Structure class for use in Table 3 of ASTM C1778: Class SC3.

F. Maximum total water-soluble chloride ion content for concrete mix including all ingredients measured as weight percent of cement in accordance with ASTM C1218:
1. All concrete: 0.10.

G. Sand Cement Grout (termed "Grout" on the Drawings):
1. Description: Typical use is for filling keyways in precast construction, and as otherwise required by the Contract Documents.
2. Performance Criteria:

a. Minimum 28 day compressive strength:
b. 3,000 PSI.
c. Strength shall be not less than strength of adjacent concrete to which grout is applied.

3. Materials:
a. Provide sand cement grout as approximately three parts sand to one part Portland cement, 4.5 percent to 7.5 percent entrained air and water to provide slump allowing grout to completely fill required spaces and surround adjacent reinforcing.
b. Provide sand in accordance with requirements for fine aggregate for concrete.

H. Non-shrink Grout:

1. Manufacturers and Products: Subject to compliance with the contract Documents, the following are acceptable:
a. Master Builders Solutions, Masterflow, 713.
b. Euclid Chemical Company, NS Grout.
c. Sika, Sika Grout 212.
d. Or equal.

2. Description:
a. This provision requires non-shrink, non-metallic grout. Unless otherwise shown or indicated in the Contract Documents, references to “non-shrink grout” refer to non-shrink, non-metallic grout required by this provision.

3. Performance Criteria:
a. Non-shrink grout shall produce a positive but controlled expansion.
b. Mass expansion shall not be created by gas liberation or by other means.
c. Minimum 28-day Compressive Strength: 7,000 PSI.

4. Material:
a. Provide material that is non-shrink, non-metallic, non-corrosive, and non-staining.
b. Comply with ASTM C1107, Grade B.
c. Premixed with water only. Add water in accordance with manufacturer’s written instructions.

I. Epoxy Grout:

1. Manufacturers and Products: Subject to compliance with the Contract Documents, the following are acceptable:
a. Master Builders Solutions, Masterflow 648.
b. Five Star Products, DP Five Start Epoxy Grout.
c. Euclid Chemical Company, E3 Flowable.
d. Sika, Sikadur 42, Grout Pak.
e. Or equal.
f. One manufacturer shall furnish both aggregate and adhesive.

2. Description:
a. Three-component epoxy resin system, comprised of two liquid epoxy components and one inert aggregate filler component.
b. Indication of locations where epoxy grout is required are indicated in the grout schedule in Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
c. Furnish each component in separate package for mixing at the Site.

3. Performance Criteria:
a. Minimum 28-day Compressive Strength: 13,000 psi.

4. Materials:
a. Aggregate shall be compatible with adhesive.

2.2 MIXES

A. Mixes - General:

1. Provide concrete capable of: (a) being placed without segregation of aggregate from other components, and (b) developing all properties necessary and required.
2. Provide ready-mix concrete in accordance with ASTM C94/C94M.
3. Batching and other tolerances shall be in accordance with ACI 117.
4. All concrete shall be normal weight concrete, unless otherwise required by the Contract Documents. Normal weight concrete shall weigh approximately 145 to 150 pounds per cubic foot (without reinforcing steel), measured 28 days after placing.

B. Concrete Mixes:

1. Mix design requirements are indicated in this Section's Table 03 31 30-A, below.

C. Air Entrainment:

1. Provide air entrainment in concrete providing total air content, expressed as percent by volume, in accordance with this Section's Table 03 31 30-A, below.
2. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures and concrete placing method.

D. Slump:

1. Slump – General:
   a. Measure slump at point of discharge of wet concrete into final location.
   b. Compensate for slump loss due to placing method.
   c. Concrete with slump less than minimum required may be used provided such concrete can be properly placed and consolidated.
   d. Slump of Concrete to be Placed by Pumping:
      1) Provide water or water-reducing admixture at ready-mix plant for concrete to be placed by pumping, to allow for slump loss due to pumping.
      2) Provide additional water sufficient only so that slump of concrete at discharge end of pump hose does not exceed: (a) maximum allowable slump indicated, and (b) maximum specified water-to-cement ratio.
   e. Slump Adjustment at the Site:
      1) Slump may be adjusted at the Site by providing water reducers.
      2) Dosing shall be performed by experienced quality control technician employed by concrete Supplier. Concrete mixing thereafter shall be directed by the same technician.
   f. Slump tolerances shall comply with ACI 117.
2. Concrete for Walls and Columns:
   a. 8 inches maximum; 4 inches minimum.
   b. Slump shall be obtained by use of mid-range or high-range water reducer complying with ASTM C494.
3. All Other Members:
   a. Concrete using water reducer in accordance with ASTM C494: 8 inches maximum; 4 inches minimum.
   b. Concrete without water reducer in accordance with ASTM C494: 5 inches maximum, one inch minimum.

E. Proportioning:

1. Proportioning - General:
   a. Proportion components of concrete to provide mixture that can be placed: (a) into corners and angles of forms, and around reinforcing, by placing and consolidation

methods employed, (b) without component materials becoming segregated, and (c) without excessive, free water to collect on concrete surface or other surfaces.

b. Proportion component elements of concrete to provide proper concrete Work, including concrete durability, strength, and other necessary and required properties.

2. Normal Weight Concrete:
   a. Normal weight concrete target cementitious materials contents and maximum water to-cementitious ratios shall be in accordance with this Section's Table 03 31 30-A, below.
   b. Target cementitious materials contents indicated in the Contract Documents are intended to provide crack-free, durable, finished concrete Work, rather than concrete Work of excessive strength.
3. SCM:
   a. SCM – General:
      1) Based on results of AAR testing by Supplier (performed in accordance with ASTM C1778) and alkali content of cement, SCM content (in accordance with this Section) may be adjusted in lieu of the indicated percentages to reduce risk associated with AAR.
      2) Use only one type of SCM in a given mix unless expressly required or approved by Engineer.
      3) Water-to-cementitious (i.e, total of SCM plus cement) ratio shall not exceed required maximum water-to-cement ratio indicated in this Section.
   b. Fly Ash:
      1) For cast-in-place concrete only, maximum of 25 percent by weight of Portland cement content, per cubic yard, may be fly ash, at rate of one pound fly ash for one pound cement.
4. Water-Reducing, Water-Retarding, and Water-Accelerating Admixtures:
   a. Provide in accordance with admixture manufacturer's written instructions.
   b. Add to mix at ready-mix plant.
   c. Use hydration stabilizer admixture, or AAR-inhibiting admixture, in concrete, as necessary and required, for placing and workability.
      1) Water reducers are required to maintain required maximum water-to-cement ratios.
5. High Range Water Reducers (Superplasticizers):
   a. Superplasticizers are required in:
      1) Concrete to be pumped, except slabs-on-grade and mats.
      2) Concrete for water-bearing structures.
      3) Other concrete Work at Contractor's option.
   b. Maximum concrete slump, before addition of admixture, shall be three inches. Maximum slump after addition of superplasticizer admixture shall be eight inches.
   c. Comply with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing, relative to superplasticizers.
6. Normal Weight Concrete Mix Proportioning:
   a. Method 1:
      1) Use Method 1 when combination of concrete component materials and mixes will be evaluated and selected via trial-and-error.
      2) Provide mixes with suitable proportions and properties in accordance with ACI 211.1, using not less than three different water-to-cementitious ratios providing a range of concrete compressive strengths, including required average compressive strength.
      3) Trial mixes shall have slump within 0.75 inches of maximum allowed in the Contract Documents. For air-entrained concrete, air content of trial batches shall be within 0.5 percent of air entrainment required by the Contract Documents.

4) For each water-to-cementitious ratio:
   a) Provide not less than three trial compressive strength tests for concrete test age required, and cure in accordance with ASTM C192.
   b) Cylinder Size: In accordance with ASTM C31.
   c) Test for compressive strength at 28 days, in accordance with ASTM C39.
      (1) Quantity of cylinders shall comply with one of the following trial strength test:
         (a) 6-inch diameter cylinders: Two.
         (b) 4-inch diameter cylinders: Three.
5) From results of such required tests, plot curve showing relationship between water-to-cementitious ratio and compressive strength.
6) Based on required curve, select water-to-cementitious ratio for the Work, that will provide concrete of required average compressive strength.
7) Provide cementitious content and mixture proportions so maximum water cement ratio is not exceeded when slump is equal to maximum allowed in the Contract Documents.
8) Required average compressive strength is indicated below in this Section.

b. Method 2:
   1) In lieu of trial mixes required by Method 1, field test results from prior projects, for concrete made using identical or substantively identical concrete component materials and proportioning, may be used by concrete supplier in determining proposed mix proportions, provided the test results are within a year of project start date.
   2) Use of proposed concrete mix proportions based on field test results from prior projects are subject to approval by Engineer. Engineer's decision will be based on information in such Submittals and demonstrated ability, of such concrete successfully provided on such prior projects, to provide required average compressive strength.
   3) Requirements for Submittals of Concrete Test Results from Prior Projects:
      a) Submittals of field test results from prior projects shall clearly indicate all materials, proportions, and conditions, and clearly indicate where such matters are similar to those required for the concrete Work on the Project.
      b) Changes in the materials, proportions, and conditions within submitted test results from prior projects shall have been not more restricted than those for the subject, proposed concrete mix.
      c) Field test reports from prior projects shall be in accordance with ACI 301 Article 4.2.3.
   4) Concrete proportions for the concrete Work may be determined from test results of prior projects via interpolation (by Contractor and concrete Supplier) between compressive strengths and proportions of two or more test results from prior projects, each in accordance with requirements of the Contract Documents for this Project.

7. Required average compressive strength shall exceed required 56 day compressive strength by the extent determined in accordance with ACI 318, Chapter 5 using the standard deviation of concrete ready-mix plant proposed for the Work as described in ACI 318, Chapter 5.

F. Allowable Shrinkage:
   1. Provide in accordance with Table 03 31 30-A of this Section, tested in accordance with ASTM C157 at 28 days.
   2. Continue testing for 64 weeks in accordance with ASTM C157 and submit results to Engineer as Informational Submittals.

3. Perform for concrete Work for all water bearing or basement structures unless expressly indicated otherwise in the Contract Documents.

TABLE 03 31 30-A							
Type of Concrete	28-day Compressive Strength	Max. W/C Ratio	Target Total Cement (pounds)	SCM	ASTM C33 Size No.	Air Content (%)	Allowable Shrinkage Limit
Normal weight concrete fill	2500 PSI	0.45	517	Note 1	57	4.5 to 7.5	NA
Normal weight precast concrete	5000 PSI	0.42	611		57	4.5 to 7.5	NA
Normal weight concrete	4500 PSI	0.40	564	Note 1	Note 2	4.5 to 7.5	0.042percent

Table 03 31 30-A Notes:

1. If fly ash or GGBFS is proposed for use, the weight of fly ash or GGBFS plus weight of Portland cement shall be used to comply with total target cement content.
2. Unless otherwise indicated, larger aggregate (No. 467) is required for concrete slabs or foundations on grade; optional elsewhere
3. For concrete using Type 1L cement, the Compressive Strength shall be taken at 56-days in place of the 28-day compressive strength.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Field Testing and Inspections:

1. Code-Required Tests and Special Inspections:
   a. Section 01 45 33 - Code-Required Special Inspections and Procedures, indicates testing scope for code-required testing and special inspections by testing entity retained by Owner or entity for whom Owner is responsible.
   b. Section 03 05 05 - Concrete Testing and Inspection, indicates required testing for concrete Work.
2. Contractor-Performed Field Testing and Inspections:
   a. Where concrete testing and inspection is required by the Contract Documents and is not part of the code-required tests and special inspections by Owner or other entity for whom Owner is responsible, such tests and inspections shall be by Contractor.
   b. Perform concrete testing and inspections in accordance with Section 03 05 05 - Concrete Testing and Inspection.
   c. Aggregates and Other Stockpiled Materials: To ensure stockpiles at the concrete mixing location are not contaminated and otherwise comply with Contract requirements, perform tests on such materials at the concrete ready-mix plant.

d. Perform strength test on all concrete to which water or superplasticizer, above the amount stated in concrete mix design Submittal approved by Engineer, has been added.

   1) Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

END OF SECTION

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SECTION 03 31 31

CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 11 13 - Formwork.
3. Section 03 21 00 - Reinforcement.
4. Section 03 31 30 - Concrete, Materials and Proportioning.
5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
6. Section 07 92 00 - Joint Sealants.

1.2 REFERENCES

A. Terminology:

1. Terminology: Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meanings indicated below:
   a. Unless obviously meant or intended otherwise, certain words and terms used in this Section have meanings indicated in ACI CT-13.
   b. “Water-bearing concrete” means concrete surface to be in contact (whether continuously or intermittently) with water, process liquid, or slurries during intended operation of the facility, including, but not limited to, concrete tanks, channels, wet wells, distribution chambers, and secondary containment structures.

B. Reference Standards: Standards referenced in this Section include, but are not necessarily limited to, the following:

1. American Concrete Institute (ACI):
   a. CT-13, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
   d. 304.2R, Placing Concrete by Pumping Methods.
   e. 305R, Guide to Hot Weather Concreting.
   f. 305.1, Specification for Hot Weather Concreting.
   g. 306R, Guide to Cold Weather Concreting.
   h. 306.1, Standard Specification for Cold Weather Concreting.
   i. 308.1, Specification for Curing Concrete.
   j. 309R, Guide for Consolidation of Concrete.
   k. 318, Building Code Requirements for Structural Concrete and Commentary.
   l. 350, Code Requirements for Environmental Engineering Concrete Structures.
   m. 360R, Guide to Design of Slabs-on-Ground.
2. ASTM International (ASTM):
   a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

3. National Ready Mixed Concrete Association (NRMCA):
   a. Checklist for Certification of Ready Mixed Concrete Production Facilities.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate concrete placement Work with other Work, and work of other contractors (if any), that must be installed prior to placement of concrete.
   2. Inform other contractors, if any, affected by the concrete Work of intended date(s) of placement of concrete. Provide sufficient advance notice to allow other contractors to perform their work that is to be completed prior to placing of concrete.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Concrete Supplier:
      a. Ready mix plant shall comply with NRMCA Checklist for Certification of Ready Mixed Concrete Production Facilities.
   2. Installer:
      a. Where the Work includes installing prefabricated waterstops, each worker of installer that will field-weld or splice prefabricated waterstops shall possess current, valid certification in field-welding and installing of the associated manufacturer's prefabricated waterstops. Submit to Engineer copies of certifications for workers.
   3. Independent Testing Laboratory for Waterstops:
      a. Testing shall be performed by an independent laboratory complying with requirements of the generally recognized accrediting entity for the jurisdiction where the Site is located.
      b. Testing laboratory shall obtain all concrete samples and waterproofing product samples from the manufacturer of the associated product or material.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Scaled (minimum 1/8 inch per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
      b. Drawing indicating location, size and type of prefabricated waterstop joints.
   2. Product Data including:
      a. Manufacturers and types:
         1) Joint fillers.
         2) Curing agents.
         3) Construction joint bonding adhesive.
         4) Prefabricated waterstops.
      b. Acknowledgement that products submitted meet requirements of standards referenced.
   3. Samples:

a. Sample of each type of prefabricated waterstop proposed for the Work, when requested by Engineer.

4. Monitoring Procedures:

B. Informational Submittals: Submit the following:

1. Delivery Tickets:
   a. Copies of concrete delivery tickets.
2. Supplier Instructions:
   a. Procedure for adding high-range water reducer at the Site.
   b. Instructions for handling and installing products approved by Engineer.
3. Field Quality Control Submittals:
   a. Results of tests, inspections, and other quality control activities required by the Contract Documents, including Section 03 05 05 - Concrete Testing and Inspections, and this Section's "Field Quality Control" Article performed at the Site.
4. Supplier Site Visit Reports:
   a. Report of each visit to the Site by Supplier, summarizing purpose of visit, activities while onsite, problems encountered, advice given to Contractor or Subcontractor, and actions taken.
5. Special Procedure Submittals:
   a. Description of proposed curing methods.
6. Qualifications:
   a. Ready-mix plant certification, in accordance with this Section's "Quality Assurance" Article.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Concrete Delivery:

1. Prepare a delivery ticket for each load of ready mixed concrete.
2. Truck operator shall hand ticket to Contractor at the time of delivery.
3. Ticket to show:
   a. Mix identification.
   b. Quantity delivered.
   c. Quantity of material in each batch.
   d. Outdoor temperature in the shade at location of concrete placement.
   e. Time at which cement was added.
   f. Time of delivery.
   g. Time of discharge.
   h. Quantity of water that may be added at the site without exceeding the specified water-cement ratio.
   i. Quantity of any water added at the Site.

1.7 PROJECT CONDITIONS

A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.

1. Do not use revised concrete mixes until submitted to and approved by Engineer.

1.8 SEQUENCING AND SCHEDULING

A. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.

1. Engineer's approval of concrete mix design does not relieve Contractor of responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.

B. Neoprene Expansion Joint Fillers:

1. Acceptable manufacturers:
   a. Permaglaze.
   b. Rubatex.
   c. Williams Products.
   d. Or equal.
2. Materials:
   a. Closed cell neoprene.
   b. ASTM D1056, Type 2, Class A or C.
   c. Grade: Compression deflection as required to limit deflection to 25 percent of joint thickness under pressure from concrete pour height.

C. Asphalt Expansion Joint Fillers:

1. Acceptable manufacturers:
   a. W.R Meadows.
   b. J and P Petroleum Products.
   c. Or equal.
2. Materials: ASTM D994.

D. Fiber Expansion Joint Fillers:

1. Materials: ASTM D1751.

E. Waterstops, PVC Type:

1. Acceptable manufacturers:
   a. Sika Greenstreak Plastic Products.
   b. W.R Meadows.
   c. Vinylex Corporation.
   d. Bometals, Inc.
   e. Or equal.
2. Materials:
   a. Virgin polyvinyl chloride compound not containing scrap or reclaimed materials or pigment.
   b. Cast-in-place type: USACE CRD-572.
3. Approved profiles as listed.
   a. Construction joints:
      1) Ribbed: 6 inches wide by 3/8 inch.
      2) Sika Greenstreak Plastic Products Style #679, or equal.
   b. Control joints:
      1) 6-inch wide by 3/8 inch thick with ribs and center bulb.
      2) Sika Greenstreak Plastic Products Style #705, or equal.
   c. Expansion joint:
      1) 9 inches wide by 3/8 inch thick center bulb two inch outside diameter.
      2) Sika Greenstreak Plastic Products Style #739, or equal.
   d.

4. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum six inches clear of the intersection.
5. Factory prepunched (less than 1.5 feet on centers, each edge, staggered) for wire supports.
   a. Provide hog rings or grommets at all punched holes along the length of the waterstop.
6. See Drawings for application and other requirements.

F. Water Swelling Sealant:
1. Required adhesive for use with strip-type waterstop.
2. Compatible with strip-type waterstop.
3. Single component, gun applied.
4. Moisture cured.
5. Minimum 70 percent volumetric expansion swelling capability.

G. Evaporation Retarder:
1. Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. Manufacturers and Products:
   a. BASF, Masterkure ER 50.
   b. Euclid Chemical Company; Eucobar.
   c. WR Meadows; EVAPRE.
   d. Or equal.

H. Curing Materials shall comply with one or more of the following:
1. Moisture Retaining Covers.
   a. Plastic Film: ASTM C171, not less than 10 mils thickness polyethylene film.
   b. Reinforced Curing Paper: Complying with ASTM C171.
   c. Moisture Retaining Fabric.
      1) Comply with ASTM C171.
         a) A naturally colored, non-woven polypropylene fabric with 4-mil non-perforated reflective (white) polyethylene coating containing stabilizers to resist degradation from ultraviolet light.
         b) Fabric shall exhibit low permeability and high moisture retention.
         c) Products:
            (1) PNA Construction Technologies, Inc.; Hydracure M15.
            (2) Reef Industries Inc; Transguard 4000.
            (3) Or equal.
2. Dissipating curing compound:
   a. Fugitive dye, waterborne, membrane-forming.
   b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions to not impair the later addition and performance of applied finishes.
   c. Products and Manufacturers:
      1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
      2) Euclid Chemical Company; Kurez DR VOX.
      3) L&M Construction Chemicals, Inc.; L&M Cure R.
      4) Or equal.
3. Clear, water or solvent-borne, membrane-forming curing and sealing compound:

a. ASTM C1315, Type 1, Class A.
b. Moisture loss shall be not more than 0.40 kilograms per square meter when applied at 300 square feet per gallon.
c. Manufacturer's certification is required.
d. Subject to Project requirements, provide one of the following products:
1) Solvent-based:
a) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
b) L&M Construction Chemicals, Inc.; Lumiseal Plus.
c) W.R. Meadows, Inc.; CS-309/30.
d) Or equal.
2) Water-based:
a) Euclid Chemical Company; Super Diamond Clear VOX.
b) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
c) W.R. Meadows, Inc.; Vocomp-30.
d) Or equal.

I. Sand cement grout, non-shrink grout and epoxy grout: Comply with Section 03 31 30 - Concrete Materials and Proportioning.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installing the Work constitutes Contractor's approval of underlying work, substrates, and field conditions prevailing at the time of the Work.

3.2 PREPARATION

A. Preparation – General:
1. Materials and construction shall comply with the tolerances as specified in ACI 117.
2. Complete formwork.
a. Perform formwork in accordance with Section 03 11 13 - Formwork.
3. Remove earth, snow, ice, water, foreign matter, and other extraneous materials from areas that will receive concrete.
4. Secure reinforcement in place.
a. Provide reinforcing in accordance with Section 03 21 00 - Reinforcement.
5. Provide expansion joint material, anchors and other embedded items.
6. Prior to placing concrete, obtain Engineer's concurrence that associated formwork and reinforcing appear to be in accordance with the Contract Documents. However, in no event will Engineer's observations, comments, or concurrence that any part of the Work appears to be in accordance with the Contract Documents modify or reduce Contractor's sole responsibility for providing Work in accordance with the Contract Documents.
7. Do not place concrete during rain, sleet, snow, or other adverse ambient or environmental conditions unless adequate protection is provided by Contractor and such placement is acceptable to Engineer.
a. Provide sufficient quantity of competent, experienced workers with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
b. Do not allow precipitation or storm water runoff to increase mixing water nor to damage surface finish.
8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.

9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
    a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:
    1. Subgrade shall be wetted without standing water immediately prior to placing concrete.
    2. Obtain Engineer's acceptance of subgrade compaction density prior to placing slabs on ground.

C. Edge Forms and Screeds:
    1. Set accurately to produce designated elevations and contours of finished surface.
    2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
    3. Use strike off templates, or acceptable vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.3 CONCRETE MIXING

A. Concrete Mixing - General:
    1. Provide concrete materials from one ready-mix batch plant qualified in accordance with this Section's "Quality Assurance" Article.
    2. Batch, mix, and transport in accordance with ASTM C94/C94M.

B. Control of Admixtures:
    1. Control at ready-mix plant:
        a. Admixtures shall be introduced at the ready-mix plant in accordance with manufacturer's recommendations.
        b. Charge admixtures into mixer as solutions.
            1) Measure by means of an appropriate mechanical dispensing device.
            2) Liquid considered a part of mixing water.
            3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
        c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
        d. Complete performing addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.
    2. Control of Admixtures at the Site:
        a. Additional quantities of admixtures (with the exception of retarders) may be added at the Site provided:
            1) Addition of admixtures shall be under the supervision of the ready-mix plant's quality control representative.
            2) Addition of each admixture shall be documented on the delivery ticket.
            3) Provide additional mixing in accordance with ASTM C94.

C. Tempering and Control of Mixing Water:
    1. Mix concrete only in quantities for immediate use.
    2. Discard concrete which has set.
    3. Discharge concrete from ready-mix delivery vehicles within time limit stated in ASTM C94.
    4. Addition of water at the Site:
        a. Comply with Section 03 31 30 - Concrete Materials and Proportioning, for specified water cement ratio and slump.

b. Do not exceed maximum specified water cement ratio or slump.

c. Incorporate water by additional mixing equal to at least half of total mixing required.

D. If the time required to discharge concrete exceeds the time limits per ASTM C94, consider the use of hydration stabilizers added at the batch plant. See Section 03 31 30 - Concrete Materials and Proportioning.

3.4 PLACING OF CONCRETE

A. Placing of Concrete - General:

1. Place concrete at a rate such that concrete, which is being integrated with fresh concrete, is “workable”.
   a. Provide sufficient, competent, skilled workers for timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
2. Comply with ACI 304R ,ACI 304.2R, and ACI 301.
3. Do not begin placing concrete during rain, sleet, snow, or other adverse weather or environmental conditions that may be detrimental to concrete placement.
   a. Protect fresh concrete from ensuing inclement weather and other environmental conditions that may be detrimental to concrete.
4. Time between concrete batching and final placement shall not exceed 90 minutes,.
   a. Selection of time limit to end of discharge should consider ambient conditions, types of cementitious materials and admixtures used, placement procedures, and projected transportation time between ready-mix plant and the point of delivery.
   b. If discharge is acceptable after more than 90 minutes have elapsed since batching, verify that air content of air-entrained concrete, slump, and temperature of concrete are as specified.
5. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
6. Begin work only when work of other trades affecting concrete is complete.
7. When pumping concrete, do not use excess grout or mortar to lubricate concrete conveyance piping.
8. Do not use excess water for workability or any reason when placing concrete by freefall.
9. Deposit concrete continuously to avoid cold joints.
10. Provide construction joints at locations shown or indicated in the Contract Documents, unless otherwise approved by Engineer via Shop Drawing or Contract modification.
    a. Plan size of crews with due regard for effects of concrete temperature and ambient conditions to avoid unplanned cold joints.
11. Spreaders:
    a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
    b. Embedded:
       1) Obtain approval of Engineer for their use.
       2) Materials: Concrete or metal.
       3) Ends of metal spreaders coated with plastic coating two inches from each end.
12. Do not begin placing of concrete in supported elements until concrete previously placed in supporting members is no longer plastic and has been in place at least a minimum of 2 hours.
13. Deposit concrete as nearly as practicable in its final position to avoid segregation.
    a. Maximum free fall: 4 feet.
    b. Place concrete by means of hopper, “elephant trunk” or tremie pipe extending to within four feet of surface.
14. Perform the following operations before bleeding water has an opportunity to collect on surface:

a. Spread.
b. Consolidate.
c. Straightedge.
d. Darby or bull float.

15. No water shall be added to the concrete surface to ease finishing operation.
16. Do not discharge water into forms.
17. Consider use of form vibrators for certain placement situations.

B. Cold Weather Concrete Placement:

1. Comply with ACI 306.1.
2. Do not place concrete on forms or subgrades that are below 32 degrees F or contain frozen material.
3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
4. Temperature of concrete when discharged at site: in accordance with ACI 306.1.
5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 degrees F, when temperature of surrounding air is 40 degrees F or below at time concrete is placed.
   a. Remove frost from subgrade, forms and reinforcement before concrete is placed.
6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 degrees F.
7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 degrees F.
8. Comply with ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.

C. Hot Weather Concrete Placement:

1. Comply with ACI 305.1.
2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
3. Temperature of concrete at point of delivery (i.e. delivery vehicle discharge) when placed:
   a. Not to exceed 90 degrees F.
   b. Not so high as to cause:
      1) Shrinkage cracks.
      2) Difficulty in placement due to loss of slump.
      3) Flash set.
4. Temperature of forms and reinforcing when placing concrete:
   a. Not to exceed 90 degrees F.
   b. May be reduced by spraying with water to cool below 90 degrees F.
      1) Leave no standing water to contact concrete being placed.
5. Prevent plastic shrinkage cracking, slab curling, or both due to evaporation.

D. Consolidating:

1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
   a. Ensure no displacement of reinforcing or other embeds from final position.
   b. Eliminate:
      1) Air or stone pockets.
      2) Honeycombing, pitting, or both.

3) Planes of weakness.

3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
   a. Size and coordinate external vibrators to specifically match forming system used.
4. Internal vibrators:
   a. Minimum frequency of 8000 vibrations per minute.
   b. Insert and withdraw at points approximately 1.5 feet apart.
      1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
   c. Use in:
      1) Beams and girders of framed slabs.
      2) Columns and walls.
      3) Vibrating concrete around all waterstops.
   d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other appropriate means.
6. Do not use vibrators to transport concrete within forms.
7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the Work.
8. Provide sufficient spare vibrators at the Site during all concrete placing operations to ensure continuous vibration.
9. Bring a full surface of mortar against form by vibration supplemented, if necessary, by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
10. Prevent construction equipment and machinery, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
   1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
   2. Temporary horizontal belt conveyors:
      a. Mount at a slope which will not cause segregation or loss of ingredients.
      b. Protect concrete against undue drying or rise in temperature.
      c. Use an arrangement at discharge end to prevent segregation.
      d. Do not allow mortar to adhere to return length of belt.
      e. Discharge conveyor runs into equipment specially designed for spreading concrete.
   3. Temporary metal or metal lined chutes:
      a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
      b. Chutes more than 20 feet long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
      c. Provide end of each chute with a device to prevent segregation.
   4. Temporary pumping or pneumatic conveying equipment:
      a. Designed for concrete application and having adequate pumping capacity.
      b. Control pneumatic placement so segregation is avoided in discharged concrete.
      c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1.5 inches.

d. Do not convey concrete through pipe of aluminum or aluminum alloy.

e. Provide pumping equipment without Y sections.

3.5 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - General:

1. Provide joints at locations as shown or indicated on the Drawings or as shown on approved Shop Drawings approved by Engineer or in an appropriate Contract modification.
   a. Where construction joint spacing shown on the Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Section.
2. Unplanned construction joints are unacceptable.
   a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
   a. At Contractor's option, beam pockets may be formed into concrete walls.
   b. Size pockets to allow beam reinforcing to be placed as detailed on the Drawings.
5. Place beams, girders, column capitals and drop panels at same time as slabs.
6. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
7. Provide the following joints unless shown or indicated otherwise on the Drawings:
   a. Roughen joints: horizontal construction joints.
   b. Keyed joints: vertical construction joints.
8. Roughen construction joints:
   a. Clean the previously hardened concrete interface and remove all laitance.
   b. Intentionally roughen the interface to a full amplitude of 0.25 inch.
9. Keyways:
   a. Construction joint keyways shall have the following dimensions, unless shown or indicated otherwise on the Drawings or as directed by Engineer.
   b. Wall keys:
      1) Keyway width, not less than one-third and not more than one-half the wall thickness measured perpendicular to wall faces.
      2) Keyway depth shall be not less than 1.5 inches.
      3) Continuous along length of wall.
      4) Place keyway in wall center unless otherwise shown or indicated on the Drawings.
   c. Keyways in footings, foundations, base slabs, and structural or elevated slabs:
      1) Keyway height not less than one-third and not more than one-half the footing or slab thickness.
      2) Keyway depth not less than 1.5 inches.
      3) Continuous along footing or slab.
      4) Keyway in footing or slab center unless shown otherwise on the Drawings.
10. Minimum time before placement of adjoining concrete construction:
    a. All concrete: 60 hours, unless otherwise noted.

B. Construction Joints - Spacing Unless Otherwise Specified:

1. Structures not intended to contain liquid:

a. Wall vertical construction joints:
   1) 50 feet maximum on centers.
   2) At wall intersections, four feet minimum from corner.
b. Base slab, floor, and roof slab construction joints:
   1) Placements to be approximately square and not to exceed 4,000 square feet.
   2) Maximum side dimension of a slab pour shall be 90 feet.

2. Water bearing structures:
   a. Wall vertical construction joints:
      1) 30 feet maximum on centers.
      2) At wall intersections, six feet minimum from corner.
   b. Wall horizontal construction joints: 10 feet on centers.
   c. Floor slab, construction joints:
      1) Placements to be approximately square and not to exceed 2,000 square feet.
      2) Maximum side dimension of a slab pour to be less than:
         a) Twice the length of the short side.
         b) 60 feet.
   d. Elevated slab construction joints:
      1) Placements to be approximately square and not to exceed 4,000 square feet.
      2) Maximum side dimension of a slab pour to be less than:
         a) Twice the length of the short side.
         b) 70 feet.

C. Construction Joints - Bonding:
   1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
   2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as indicated below:
   3. Roughen construction joints:
      a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 0.25 inch minimum amplitude.
         1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
   4. Keyed construction joints:
      a. Thoroughly clean construction joints and remove all laitance.
      b. Dampen the hardened concrete immediately prior to placing of fresh concrete.

D. Slab On Grade Joints:
   1. Locate construction and control joints in slabs on grade as shown or indicated on the Drawings.
   2. Time cutting properly with set of concrete, if saw cut joints are required or allowed.
      a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
      b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:
   1. Do not allow reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
   2. Use neoprene expansion joint fillers, unless shown or indicated otherwise on the Drawings.

3. Seal expansion joints as shown or indicated on the Drawings.
    a. Comply with Section 07 92 00 - Joint Sealants.

F. Waterstops - General:
1. Waterstop shall be continuous with splices in accordance with manufacturer's instructions and create water-tight joints.
2. Do not mix different types of waterstop materials in the same structure without approval from the Engineer unless shown or indicated on the Drawings.
3. Preformed strip type:
    a. Locate waterstop at center of wall, unless shown or indicated otherwise on the Drawings.
        1) Maintain at least three inches from edge of concrete or as recommended by manufacturer.
    b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
    c. Roughened joints shall be specially prepared during concrete placement to provide smooth surface for proper water stop installation.
    d. Use in joints against existing concrete where shown or indicated on the Drawings.
4. PVC waterstops:
    a. Pre-position waterstop accurately in joints, with adequate clearance from all reinforcing. Do not push waterstop into wet concrete.
    b. Secure waterstops in correct position using hog rings or grommets spaced no more than 1.5 feet maximum staggered along each edge full length and passed through the edge of the waterstop.
        1) Tie wire to adjacent reinforcing.
    c. Hold horizontal waterstops in place with continuous supports.
    d. Install according to manufacturer's instructions.
        1) Do not displace reinforcement from required location.
    e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
        1) Use factory fabricated "T" and corner intersection fittings.
        2) Field splice straight runs of material.
    f. Unless otherwise noted, provide for construction joints in new construction for all structures indicated on the Drawings.

G. Other Embedded Items:
1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.

H. Placing Embedded Items:
1. Support against displacement.
2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
3. Provide adequate means for anchoring waterstop in concrete.

3.6 FINISHING

A. Comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

B. Coordinate mixing and placing with finishing.

3.7 INSTALLATION OF GROUT

A. Grout Schedule:

1. Sand cement grout:
   a. Fill keyways in precast HCU.
   b. Construction joint bedding (base of wall pours with comparable compressive strength to wall).
   c. General use.
   d. As shown or indicated on the Drawings.
2. Non-shrinking non-metallic grout:
   a. Filling form tie holes.
   b. Under column and beam base plates.
   c. Other uses shown or indicated on the Drawings.
3. Epoxy grout:
   a. Patching cavities in concrete.
   b. Grouting of dowels and anchor bolts into existing concrete.
   c. Grouting of rotating or oscillating equipment base plates where driving motor is 500 horsepower and above.
   d. As shown or indicated on the Drawings.

B. Grout Installation:

1. Sand cement grout:
   a. Fill wetted keyways between precast concrete hollow core slabs with sand cement grout.
   b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
   c. Cure grout by one of methods specified.
2. Non-shrink non-metallic grout:
   a. Clean concrete surface to receive grout.
   b. Saturate concrete with water for 24 hours prior to grouting.
   c. Mix in a mechanical mixer.
   d. Use no more water than necessary to produce flowable grout.
   e. Place in accordance with manufacturer's instructions.
   f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast-in-place slabs, and in other locations shown or indicated on the Drawings.
   g. Completely fill spaces and cavities below the top of base plates.
   h. Provide forms where base plates and bed plates do not confine grout.
   i. Where exposed to view, finish grout edges smooth.
   j. Except where a slope is shown or indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
   k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
3. Epoxy grout:
   a. Mix and place in accordance with manufacturer's written instructions.
   b. Apply only to clean, dry, sound surface.
   c. Completely fill cavities and spaces around dowels and anchors without voids.
   d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
   e. Obtain manufacturer's field technical assistance as necessary to ensure proper placement.

3.8 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.

1. Comply with ACI 308.1 except as modified herein.
2. Do not impose loads by foot traffic, wheeled traffic, and other loads until concrete has sufficiently cured to carry imposed loads without adversely affecting the concrete. In no event shall concrete be subject to loading or traffic during initial 48 hours of curing, unless otherwise approved by Engineer.

B. Apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).

1. Ponding or continuous sprinkling. Avoid eroding the surface of freshly placed concrete.
2. Application of wet Absorbent Covers:
   a. Minimum lap: 12 inches.
   b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as necessary to keep concrete surface continuously wet.
   c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
3. Continuous application of steam (not exceeding 150 degrees F) or mist spray.
4. Application of Moisture Retaining Cover sheet materials.
   a. Place as soon as possible after final finishing and without marring the surface.
   b. Minimum lap: 12 inches.
   c. Seal edges to make water-tight.
   d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
   e. Hold cover and edges in place as necessary to prevent wind from displacing the cover.
   f. Moisture Retaining Fabric:
      1) Install in accordance with manufacturer’s written recommendations.
      2) Saturate concrete surface and fabric side of cover immediately prior to placing.
   g. Monitor continuously during the curing period:
      1) Repair holes, tears or displaced cover.
      2) Rewet as necessary to keep concrete moist under cover.
5. Application of other moisture retaining covering acceptable to Engineer.
6. Water used for curing shall be within 20 degrees F of the concrete temperature.
7. Application of a curing compound.
   a. Apply curing compound in accordance with manufacturer's written recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
   b. Do not use on surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
   c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
      1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
      2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
      3) Allow the preceding coat to completely dry prior to applying the next coat.
      4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.

8. Surfaces In Contact with Forms:
    a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
        1) See Section 03 11 13 - Formwork.
    b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
    c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
    d. After form removal, cure concrete until end of time prescribed.
    e. Use one of the methods listed above.
    f. Forms left in place shall not be used as a method of curing in hot weather.
    g. The term "hot weather", where used in these Specifications, is defined in ACI 305.1.
    h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

C. Curing Period:
    1. Continue curing for at least seven days for all concrete except Type III, high early strength concrete for which period shall be at least three days.
        a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.

D. Cold Weather:
    1. Comply with of ACI 306.1.
    2. Maintain temperature of concrete in accordance with ACI 306.1 for a minimum of 72 hours after concrete is placed, when outdoor temperature is 40 degrees F, or less.
        a. Maximum temperature rate of decrease: In accordance with ACI 306.1.
    3. Provide temporary heating, covering, insulating, or housing of the concrete Work to maintain required temperature without damage due to concentration of heat.
    4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
    5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

E. Hot Weather:
    1. Comply with ACI 305.1 and ACI 308.1.
    2. Provide as necessary cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
    3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
    4. Maximum temperature rate of decrease: In accordance with ACI 305.1.

F. Rate of Temperature Change:
    1. Maintain temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing.

G. Mass Concrete:
    1. Curing: Method of curing shall be as described above.
    2. Curing and insulating period:
        a. All formed and unformed exposed concrete surfaces shall be insulated during the curing.

b. The insulation monitoring period shall be a minimum of seven days or longer as necessary, as indicated in the “Monitoring Period“ provision below.

c. Insulation requirements shall be based on the air temperature surrounding the concrete.

1) Provide a minimum of one layer of commercially available concrete temporary insulating blanket with a minimum R-value of 5.

2) Other materials of similar R-value may be acceptable to Engineer.

3. Monitoring Period:

a. Surface Temperature:

1) During curing and insulating, surface temperature of concrete shall be monitored a minimum of twice per day until surface temperature of mass concrete falls to within 30 degrees F of ambient air temperature surrounding mass concrete.

2) During this monitoring period, surface temperature of mass concrete shall not drop more than 15 degrees F over a 24 hour period.

a) If temperature drop is exceeded while insulation is in place, increase insulation for remainder of monitoring period.

b) If temperature drop is exceeded at end of monitoring period, insulation shall be reinstalled and left in place for 24 hours.

3) Do not artificially cool surface of mass concrete with water or other means during the monitoring period.

b. Core temperature:

1) Insulation of concrete surfaces(s) shall continue until temperature differential between concrete section core temperature and concrete section surface temperature is less than 35 degrees F for longer than three days.

2) Maximum temperature in concrete after placement shall not exceed 158 degrees F.

c. Provide necessary temporary thermometers and temperature measuring equipment for monitoring concrete and ambient air temperature during Monitoring Period.

1) Record times and temperatures during the Monitoring Period.

2) Allow Engineer and Special Inspector to witness the results of each temperature reading.

H. Protection from Mechanical Damage:

1. Protect concrete from damage of all types, whether or not mechanically imparted including load stresses, heavy shock, and excessive vibration.

2. Protect finished concrete surfaces from all types of damage, including damage by construction equipment and machinery, construction means and methods, precipitation, and running water.

3. Do not load self-supporting structures in such a way as to overstress concrete.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Special Inspections in accordance with building code:

a. Comply with 03 05 05 - Concrete Testing and Inspection.

2. Inspections, Non-Code Required.

a. Waterstops:

1) Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.

2) Frequency:

a) Prior to each concrete pour

3) Testing PVC Waterstop Joints:

a) Samples of field fabricated waterstop butt joints may be selected at random by the Engineer for testing by a laboratory at the Owner's expense.

(1) When tested, they shall have a tensile strength across the joints equal to at least 600 psi.

B. Supplier’s Onsite Services:

1. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete finishing and repair of surface defects.
2. Chemical Sealers.
3. Polymer Modified Cementitious Coating.
4. Resurfacing Mortar.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 11 13 - Formwork.
2. Section 03 31 30 - Concrete, Materials and Proportioning.
3. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. CT-13, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
   d. 308, Standard Practice for Curing Concrete.
2. ASTM International (ASTM):
   a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
   b. C150, Standard Specification for Portland Cement.
   c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
   h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   i. D4259, Standard Practice for Abrading Concrete.
   j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
   k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.
3. International Concrete Repair Institute (ICRI):
   a. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
   b. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

4. National Council Highway Research Program (NCHRP):
    a. 244, Concrete Sealers for the Protection of Bridge Structures.
5. The Society for Protective Coatings/NACE International (SSPC/NACE):
    a. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
1. Chemical Sealer CS-2:
    a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
    b. Applicator shall have a minimum of five years of experience successfully applying materials specified.

C. Mock-Ups.
1. General:
    a. Construct additional mock-ups as required until accepted.
    b. Mock-ups constitute minimum standard of quality for actual construction.
    c. Maintain mock-up during construction.
    d. Remove when directed by Engineer.
2. Construct mock-up for each type of wall finish specified for review and acceptance by Engineer.
    a. Minimum 4 x 4 feet area for each different wall finish specified.
    b. Mock-ups shall include:
        1) Sample of patched tie hole.
        2) Sample of all jointery being used in the walls.
    c. Include mock-up of wall having polymer modified cementitious coating.
        1) Mock-up shall be stepped to show surface preparation, repairs and coating in all stages of application.
3. Construct mock-up floor slab for review and acceptance by Engineer.
    a. Minimum 10 x 10 feet.

1.3 DEFINITIONS

A. Vertical Surface Defects:
1. Any void in the face of the concrete deeper than 1/8 inches, such as:
    a. Tie holes.
    b. Air pockets (bug holes).
    c. Honeycombs.
    d. Rock holes.
2. Scabbing:
    a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
3. Foreign material embedded in face of concrete.
4. Fins 1/16 inches or more in height.

B. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

C. Other words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
2. Certifications:
   a. Certification of aggregate gradation.
   b. Certification of manufacturer experience qualifications and performance history.
   c. Certification of applicator's qualifications.
      1) Refer to Qualifications paragraph.
      2) Provide manufacturer's written approval of applicators.
      3) Provide references substantiating specialty experience.

B. Informational Submittals:

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Bonding Agents:
   a. Master Builders Solutions.
   b. Euclid Chemical Co.
   c. Laticrete - L&M Construction Chemicals.
2. Chemical Sealers:
   a. Master Builders Solutions.
   b. Euclid Chemical Co.
   c. Laticrete - L&M Construction Chemicals.
   d. Tnemec Chemprobe.
3. Polymer Modified Cementitious Coating:
   a. Aquafin International.
   b. Master Builders Solutions.
   c. Euclid Chemical Co.
4. Patching Mortar:
   a. Master Builders Solutions.
   b. Euclid Chemical Co.
   c. Laticrete - L&M Construction Chemicals.
   d. Sika Corporation.

2.2 MATERIALS

A. Chemical Sealer CS-1:

1. High solids, water-based solution containing acrylic copolymers.
   a. ASTM C1315, Type I, Class A.
   b. Non-yellowing UV resistant.
   c. VOC Content: <200 G/L.

2. USDA approved as a concrete floor sealer.
3. Euclid Chemical Super Diamond Clear VOX.

B. Chemical Sealer CS-2:

1. Water based chemical solution containing a blend of silicate and siliconate polymers designed to seal, harden and dustproof concrete floors.
2. VOC Content: 0 G/L.
3. Performance of treated concrete floor:
   a. Coefficient of Friction:
      1) Dry: 0.81.
      2) Wet: 0.72.
   b. Liquid repellency, RILEM Method 11.4:
      1) ≥ 1 mL.
4. Euclid Chemical Euco Diamond Hard.

C. Chemical Sealer CS-3:

1. Clear, penetrating, breathable, waterborne silane-siloxane solution.
2. VOC content: ≤50 G/L.
3. Odorless.
4. Flash point: >200 degrees F.
5. Water absorption: 85% reduction per NCHRP 244.
6. Chloride penetration: 82% reduction per NCHRP 244.
7. Euclid Chemical Baracade WB 244.

D. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.

1. Portland cement-based, rapid set repair mortar for interior or exterior use.
2. Compressive Strength, ASTM C109:
   a. Minimum 3000 psi at 7 days.
   b. Minimum 5000 psi at 28 days.
3. Freeze Thaw Durability, ASTM C666: 96.75% at 300 Cycles.
4. Shrinkage, ASTM C157: 0.069%.
5. Euclid Chemical Speed Crete Red Line.

E. Bonding Agents:

1. For use only on concrete surfaces not receiving liquid water repellent coating:
   a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
      1) Master Builders MasterEmaco A 660.
      2) Euclid Chemical Co. Flex-Con.
      3) Laticrete L&M Everbond.
2. For use only on concrete surface receiving liquid water repellent:
   a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.

F. Cement:

1. ASTM C150, Type I Portland elsewhere.

G. Aggregate:

1. Sand: Maximum size #30 mesh sieve.

2. For exposed aggregate finish surfaces: Same as surrounding wall.

H. Water: Potable.

I. Polymer modified cementitious coating:

1. Polymer modified Portland cement based coating for concrete and masonry.
   a. Waterproof.
   b. Resistant to both positive and negative hydrostatic pressure.
   c. Breathable.
2. Master Builders Solutions MasterSeal 581 or Euclid Chemical Tamoseal.
   a. Color:
      1) Interior surfaces: Standard gray.
      2) Exterior surfaces: Standard gray.
   b. Texture: Fine.

J. Nonshrink Grout: See Specification Section 03 31 30 and Specification Section 03 31 31.

2.3 MIXES

A. Bonding Grout: One part cement to one part aggregate.

B. Patching Mortar:

1. One part cement to 2-1/2 parts aggregate by damp loose volume.
   a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. For methods of curing, see Specification Section 03 31 31.

B. Surface Preparation:

1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
   a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
      1) Areas to receive Repair Mortar:
         a) Areas larger than 1 SF or deeper than 1/4 inches Abrasive blast, scarify or needle scale to CSP No. 6-8.
      2) Areas to receive Resurfacing Mortar: Shot blast, scarify or Abrasive blast to CSP No. 5-7.
   b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
   c. No featheredges will be permitted.
   d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.
   e. Prepare corroded steel in accordance with ICRI 310.1R.

C. Preparation of Bonding Grout Mixture:

1. Mix cement and aggregate.
2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
3. Add bonding agent/water mixture to cement/aggregate mixture.

4. Mix to consistency of thick cream.
5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.

D. Preparation of Patching Mortar Mixture:

1. Mix specified patching mortar per manufacturer’s published recommendations.
2. For repairs exceeding 2 inches in depth, mix with clean, pre-dampened 3/8 inches pea gravel in accordance with the manufacturer’s recommendations.

E. Polymer modified cementitious coating:

1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 degrees F.

1. If necessary, enclose and heat area to between 50 and 70 degrees F during repair of surface defects and curing of patching material.
   a. Use only clean fuel, indirect fired heating apparatus.
   b. Exhaust combustion byproducts outside of work area.

B. Chemical Sealer Application:

1. General:
   a. Immediately prior to Substantial Completion, thoroughly clean floor in accordance with ASTM D4258 and prepare to receive chemical sealer.
      1) Remove previously applied membrane curing compounds.
      2) Remove soil, oils, stains, discoloration, or any other imperfection having a negative impact on the appearance of the finished floor.
   b. Apply product to floor areas indicated on the Drawings.
   c. Apply in accordance with manufacturer's published installation instructions.
2. Chemical Sealer (CS-1):
   a. Apply two uniform coats at rate recommended by manufacturer.
      1) Apply using manufacturer’s recommended equipment with a fan-tip nozzle.
      2) Do not allow material to puddle.
   b. Allow first coat to completely dry before applying second coat.
   c. Spotted or mottled appearances will not be accepted.
3. Chemical Sealer (CS-2):
   a. Apply two uniform coats at rate recommended by manufacturer.
      1) Scrub the material into the floor using a mechanical scrubber.
         a) Keep the surface wet for not less than 30 minutes.
         b) Continue scrubbing in accordance with manufacturer’s application instructions.
         c) After material has thickened, but not more than 60 minutes after application, remove all excess liquid.
      2) Thoroughly rinse with clean water to remove all residue.
         a) Damp mop with clean water to remove any streaks.
         b) Do not allow residue to dry on floor surface.
      3) Do not track material onto untreated surfaces.
   b. After rinsing, allow floor to dry completely and apply second coat following the same procedures.
   c. Final floor finish shall have uniform sheen without streaking, stains or white residue.

4. Chemical Sealer (CS-3):
    a. Apply uniform coats at rate recommended by manufacturer.
        1) Apply with fine, uniform spray or microfiber pad.
    b. Allow floor to dry completely and remove any dried residue using hot water and mild citric acid.
    c. Final floor finish shall be uniform, free of residue, and shall repel water.
    d. Apply additional coat(s) as necessary to achieve water repellent finish.

C. Repairing Surface Defects:
1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.
    a. For surfaces indicated to receive finish or coating other than those specified herein; refer to the applicable Specification Section for surface preparation requirements:
        1) High Performance Industrial Coatings: See Specification Section 09 96 00.
2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.
    a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.
    b. Scrub bond coat:
        1) Wet substrate to a saturated surface dry (SSD) condition.
        2) Mix patching mortar to a scrub coat or slurry consistency per manufacturer's published recommendations and apply to entire area.
    c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer's recommended epoxy primer.
    d. Patching Mortar Application:
        1) Mix and apply Patching Mortar per manufacturer's recommendations within the open time of the product scrub coat or any bonding agents.
        2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.
3. Allow bonding grout to set for period of time required by bonding agent manufacturer before applying patching mortar.
4. Fill all defects with patching mortar.
5. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
6. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
    a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
7. Cure patching mortar in accordance with ACI 308.

D. Concrete Finishes for Vertical Wall Surfaces:
1. General:
    a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
    b. Finish numbers not listed are "Not Used".
2. Finish #1 - As cast rough form finish:
    a. Selected forming materials are not required.
    b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
    c. Repair the following surface defects using patching mortar specified in PART 2:
        1) Tie holes.

2) Honeycombs deeper than 1/4 inches.
3) Air pockets deeper than 1/4 inches.
4) Rock holes deeper than 1/4 inches.

d. Chip or rub off fins exceeding 1/4 inches in height.

e. Provide at unexposed surfaces such as:
1) Foundations.
2) Below-grade walls not to be waterproofed.
3) Concealed surface of concrete back-up wythe in cavity wall construction.

3. Finish #2 - As cast form finish:

a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.

b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
1) Chip or rub off fins exceeding 1/8 inches in height.
2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.
(1) For contiguous repair areas larger than 1 SF or deeper than 1/4 inches Abrasive blast, scarify or needle scale to CSP No. 6-8.
b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
c) No feather edges will be permitted.
3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
4) Repair the following surface defects using patching mortar specified in PART 2:
a) Tie holes.
b) Honeycombs deeper than 1/4 inches or larger than 1/4 inches diameter.
c) Air pockets deeper than 1/4 inches or larger than 1/4 inches diameter.
d) Rock holes deeper than 1/4 inches or larger than 1/4 inches diameter.
e) Scabbing.
5) Brush blast repaired areas to match adjacent surface texture.

c. Provide this finish for:
1) Interior walls of pipe galleries , pump rooms.
2) Underside of horizontal elements adjacent to the finished surface.
3) Exposed surfaces not specified to receive another finish.

4. Finish #4 - Polymer modified cementitious coating:

a. Form facing material shall produce a smooth, hard, uniform texture.
1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.

b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
1) Chip or rub off fins exceeding 1/8 inches in height.
2) Abrasive blast and repair surface defects in accordance with Concrete Finish #2.

c. Apply decorative coating to entire surface.

1) As a mixing liquid for the coating, use bonding agent and water mixture as recommended by coating manufacturer.
2) Apply two (2) coats at 2 pounds per square yard per coat.
a) During application of first coat, complete fill all voids, depressions or other surface imperfections.

d. When second coat is set, float to a uniform texture with a sponge float.
e. Provide this finish on all exposed to view:
1) Exterior building surfaces not otherwise indicated to receive an Architectural Abrasive Blast Finish.
2) Interior walls, columns and similar vertical surfaces where indicated on Room Finish Schedule on the Drawings.
3) Underside of horizontal elements adjacent to the finished surface.
f. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

E. Related Unformed Surfaces (Except Slabs):
1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float surface to a texture consistent with that of formed surfaces.
a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
3. Continue treatment uniformly across unformed surfaces.

F. Concrete Finishes for Horizontal Slab Surfaces:
1. General:
a. Tamp concrete to force coarse aggregate down from surface.
b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
c. Dusting of surface with dry cement or sand during finishing processes not permitted.
2. Unspecified slab finish:
a. When type of finish is not indicated, use following finishes as applicable:
1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
2) Surfaces intended to receive roofing or waterproofing membranes: Floated finish.
3) Floors: Troweled finish.
4) Garage floors and ramps: Broom or belt finish.
5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
6) All slabs to receive a floated finish before final finishing.
3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
1) Use wood or cork float.
c. During or after first floating, check planeness of entire surface with a 10 feet straightedge applied at not less than two different angles.

5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
    a. Refloat slab immediately to a uniform texture.
6. Troweled finish:
    a. Float finish surface to true, even plane.
    b. Power trowel, and finally hand trowel.
    c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
    d. Perform additional trowelings by hand after surface has hardened sufficiently.
    e. Final trowel when a ringing sound is produced as trowel is moved over surface.
    f. Thoroughly consolidate surface by hand troweling.
    g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
        1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
    h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.
7. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
8. Underside of concrete slab finish:
    a. Match finish as specified for adjacent vertical surfaces.
    b. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

A. Tolerances:
1. Finished floor slabs:
    a. Provide Floor Flatness (F_F) and Floor Levelness (F_L) in accordance with ACI 117.
        1) Measure in accordance with ASTM E1155.
    b. Slabs not indicated to be sloped:
        1) F_F: Equal or greater than 25.
        2) F_L: Equal or greater than 20.
    c. Slabs indicated to be sloped or curved:
        1) Measure in accordance with ASTM E1486.
        2) Provide slopes or curves as indicated on the Drawings.
2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
    a. Gap between a 10 feet straightedge placed anywhere and the finished surface shall not exceed:
        1) Class A tolerance: 1/4 inches.
        2) Class B tolerance: 3/8 inches.
        3) Class C tolerance: 1/2 inches.
    b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 inches.

B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

C. Provide services of manufacturer's technical representative:

1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.
3. Manufacturer's representative shall be present for installation of:
   a. Dry-shake Hardener.
   b. Heavy-duty Metallic Aggregate Topping.

3.4 PROTECTION

A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 hours following installation of sealer.

END OF SECTION

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SECTION 03 64 23
CRACK REPAIR AND INJECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Repair of cracks in existing concrete wider than specified in Article 3.1 of this Section.
2. Repair of cracks in concrete Work provided by Contractor, where approved or directed by Engineer, to remedy defective concrete Work.
3. Crack repair materials.
4. Crack repair methods.
5. Equipment used in performing crack repairs.

B. Scope:

1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals to furnish and install epoxy grout injected into cracks in concrete, in accordance with the Contract Documents.
2. Repair of spalled, damaged, deteriorated, or corroded concrete existing prior to the start of the Work is addressed in Section 03 01 30 - Repair and Rehabilitation of Existing Concrete.
3. Surface repairs of new concrete are addressed in Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 03 01 30 - Repair and Rehabilitation of Existing Concrete.
2. Section 03 05 05 - Concrete Testing and Inspection.
3. Section 03 31 30 - Concrete, Materials and Proportioning.
4. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
5. Price and Payment Procedures.

1.2 PRICE AND PAYMENT PROCEDURES

A. Repair of cracks in new concrete Work provided by Contractor are included in the Work of the associated bid/pay item under which the subject new concrete Work was provided.

1.3 REFERENCES

A. Terminology:

1. This provision indicates terminology used in this Section and in other Contract Documents that coordinate with this Section. Such terminology may or may not be indicated using initial capital letters and, when used in relation to the Work of this Section, have the meanings indicated below.
2. “Active crack” means crack in concrete with plane surfaces in a state of movement relative to each other; dynamic condition.
3. “Crack depth” means distance the crack extends from injection surface into the concrete to location where the subject crack is less than 0.002 inches wide.
4. “Effective pressure” means fluid grout pressure at point of grout entry at the injection port/nozzle. Effective pressure is gauge pressure minus hydraulic head losses in the injection system.
5. “Flushing” means removing debris and foreign matter from concrete crack to be repaired by introducing pressurized air or pressurized liquid.

6. “Gauge pressure” means reading of pressure of fluid grout, as indicated on an appropriate gauge for the service, with current, valid calibration, on discharge of the grout pump during injection of epoxy grout.
7. “Gravity feed” means filling and sealing of horizontally positioned cracks in concrete, using low-viscosity resins, by pouring and spreading onto surface or placing into purposely-formed reservoirs.
8. “MPII” means manufacturer’s printed installation instructions.
9. “Passive crack” means crack in concrete with plane surfaces not moving relative to each other.
10. “Pot life” means time during which polyurethane or epoxy resin is capable of being pumped.
11. “Refusal criteria” means zero flow of grout at proposed effective pressure for duration of five minutes.
12. “Resin” or “resin adhesive” means crack-filling material injected or introduced into crack in concrete for re-bonding the crack’s separated edges for transfer of stress across the crack and to prevent subsequent flow of water or other liquids through the crack.
13. “Sealant” means crack-filling material, with adhesive and cohesive properties, that forms seal preventing ingress and egress of liquids and gases into and from concrete.
14. “Structural crack repair” means repair of cracks in concrete required to restore structural capacity of the cracked concrete member. Structural crack repair restores ability for tensile and compressive forces transmitted across the crack through the resin adhesive placed in the crack. Structural cracks typically display dimensional offset in the out-of-plane direction.
15. The meaning of selected, other words and terminology used in this Section are indicated in ACI CT and ACI 503.7.

B. Reference Standards:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 503.7, Specification for Crack Repair by Epoxy Injection.
   c. CT, Concrete Terminology.
2. ASTM International (ASTM):
   a. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   c. D638, Standard Test Method for Tensile Properties of Plastics.
   d. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   e. D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.4 QUALITY ASSURANCE

A. Qualifications (General):

1. Entity Performing Crack Repairs:
   a. Entity performing repair of cracks in concrete, whether Contractor or Subcontractor, and including installers and applicators, shall possess not less than five years current experience repairing cracks in concrete in facilities of similar environmental exposures installing or applying materials similar to those required in this Section
   b. Entity performing crack repairs shall submit to Engineer documentation of qualifications and experience, including:
      1) Documentation of successfully completing not less than three projects of similar size and complexity to the crack repair Work of this Project within the past five years.
   c. Certification by Materials Manufacturers:

1) Installer or applicator of crack repair materials shall be certified or approved, in writing, by crack repair materials manufacturers used in the Work, for installing the crack repair materials required.

d. As an alternative, installer or applicator may be certified or approved at the Site by the materials manufacturer during initial installations in accordance with Paragraph 3.6.B of this Section.

2. Manufacturer's Representative:

a. Trained at materials manufacturers' production facilities.

b. Experienced with and capable of properly and clearly instructing entity performing crack repairs.

c. Knowledgeable of and experienced with current theories on the nature and causes of cracking in concrete.

d. Methods for repairing damaged concrete.

e. Technical aspects of correct materials selection and use.

f. Operation, maintenance, and troubleshooting of application equipment.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:

a. Material manufacturers' published technical data including:

1) Published product data, indicating properties, appropriate uses and applications, and limitations; and manufacturer's specifications.

2) Manufacturer's written acknowledgement that materials proposed comply with requirements of standards referenced in the Contract Documents.

b. Material manufacturers and types:

1) Epoxy resin adhesive.

2) Polyurethane sealant.

3) Surface seal.

4) Epoxy penetrating sealant.

5) Silane sealer.

B. Informational Submittals: Submit the following:

1. Certifications:

a. Certification of Materials for Intended Service:

1) Certification of material manufacturer, signed by person factory-trained by material manufacturer in the application of the materials proposed for use, indicating that materials and crack repair work plan have been reviewed and are suitable for the intended use on this Project.

2) Do not begin injection of cracks in concrete until crack repair methods proposed for the Work are certified by material manufacturer's technical representative and accepted by Engineer.

b. Manufacturer's Certification of Installer or Applicator:

1) Written certification or approval of material manufacturer of each proposed installer or applicator of crack repair materials, acknowledging that installer or applicator is knowledgeable regarding installing and applying each product proposed for use.

2) In lieu of written certification or approval required by the paragraph immediately above, submit certification that manufacturer's technical representative performed training for the installers or applicators at the Site in accordance with this Section.

c. Certification of calibration, and calibration records for the past year, for each pressure gauge to be used in the crack repair Work.

2. Technical data for metering, mixing, and injection equipment.

3. Manufacturer's Instructions:
    a. Repair materials manufacturers' published installation instructions.
    b. Installation instructions for repairing core holes taken at epoxy resin injection locations.
4. Qualifications Statements:
    a. Entity performing concrete crack repairs, including installers and applicators.
    b. Manufacturers' representatives performing services at the Site, when such qualifications are requested by Engineer.

C. Closeout Submittals: Submit the following:
1. Record documents that accurately depict actual locations of repaired cracks and type of crack injection materials used at each location. This may be shown and indicated on record drawings required in Section 01 78 39 - Project Record Documents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with material manufacturer's written instructions and recommendations regarding handling, delivery, and storage.

B. Storage:
1. Store materials in tightly-sealed, original containers, off the ground and in dry location with humidity controls.
2. Do not store in direct sunlight.
3. Protect materials from temperature extremes and avoid freezing temperatures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, manufacturers indicated below are acceptable for use in the Work of this Section.
1. Epoxy Resin Adhesive:
    a. Master Builders Solutions.
    b. Sika Corporation.
    c. Euclid Chemical Company.
    d. Or equal.
2. Surface Seal:
    a. Master Builders Solutions.
    b. Sika Corporation.
    c. Euclid Chemical Company.
    d. Or equal.
3. Polyurethane Sealant:
    a. Master Builders Solutions.
    b. Sika Corporation.
    c. Euclid Chemical Company.
    d. Green Mountain International.
    e. Or equal.
4. Epoxy Penetrating Sealant:
    a. Master Builders Solutions.
    b. Sika Corporation.
    c. Euclid Chemical Company.
    d. Or equal.
5. Silane Sealer:

a. Sika Corporation.
b. Or equal.

B. All materials of each type used for crack injection shall be furnished by a single manufacturer, to ensure compatibility of materials.

2.2 MATERIALS

A. Epoxy Resin Adhesive:

1. Two-part epoxy adhesive containing 100% solids, complying with the following:
   a. Compliant with ASTM C881, Type IV, Grade 1. Viscosity that allows material to achieve and maintain penetration requirements of ACI 503.7.
   b. Bond Strength: 2,000 psi in accordance with ASTM C882.
   c. Neat Tensile Strength: 7,000 psi in accordance with ASTM D638.
   d. Neat Elongation: 1.5%, minimum, at seven days at 70 degrees F, in accordance with ASTM D638.
   e. Flexural Strength: 8,000 psi in accordance with ASTM D790.
   f. Compressive Strength: 10,000 psi in accordance with ASTM D695.
2. For injection of structural cracks (active cracks and passive cracks).
3. Acceptable Products:
   a. MasterInject 1380, by Master Builders Solutions.
   b. Sikadur 35, Hi-Mod LV, by Sika Corporation.
   c. Dural 452 LV, by Euclid Chemical Company.
   d. Or equal.

B. Surface Seal:

1. Material shall seal crack faces and have sufficient strength and adhesion to contain the injection adhesive during injection and while injection adhesive cures.
2. Capable of being removed after injection, when not leave residue or damage concrete surface concrete.
3. Acceptable Products:
   a. MasterEmaco ADH 1420, by Master Builders Solutions.
   b. Sikadur 31, Hi-Mod Gel, by Sika Corporation.
   c. Dural Fast Set Gel, by Euclid Chemical Company.
   d. Or equal.

C. Polyurethane Sealant:

1. Low-viscosity, expanding, hydrophilic polyurethane chemical grout forming a flexible gasket to seal non-structural cracks in concrete.
2. Acceptable Products:
   a. MasterInject 1210 IUG, by Master Builders Solutions.
   b. SikaFix HH Hydrophilic, by Sika Corporation.
   c. Dural Aqua-Fil, by Euclid Chemical Company.
   d. Mountain Grout Gel Foam, by Green Mountain International.
   e. Or equal.

D. Epoxy Penetrating Sealant:

1. Super-low-viscosity, two-component epoxy penetrating sealer containing 100% solids.
2. Capable of being used alone to seal passive horizontal cracks less than 0.030 inches wide.
3. Acceptable Products:
   a. MasterInject 1000, by Master Builders Solutions.

b. Sikadur 55 SLV, by Sika Corporation.
c. Dural 335, by Euclid Chemical Company.
d. Or equal.

E. Silane Sealer:

1. Use only for cracks less than 0.010 inches wide, brushed onto surface.
2. Acceptable Products:
   a. Sikagard 706, by Sika Corporation.
   b. Or equal.

PART 3 - EXECUTION

3.1 CRACK REPAIR – GENERAL

A. Cracks wider than 0.012 inches in existing concrete, as shown or indicated or as directed by Engineer and designated as active crack or passive crack, and as either structural crack or non-structural crack, shall be numbered, and physically marked and measured in accordance with Article 1.2 of this Section.

B. Cracks in new concrete Work shall be repaired in accordance with this Section.

C. Crack Monitoring:

1. Engineer may require monitoring of cracks to be repaired, using crack width monitor (provided by Contractor) for period (not less than 96 hours) established by Engineer, to verify whether crack is active or passive.
2. When directed by Engineer, continue monitoring crack width for time required by Engineer to determine whether crack is at its widest, as measured at concrete surface.

D. Crack repair procedures for cracks shall be verified by material manufacturer's technical representative and shall be in conformance with the following:

1. Method 1: Repair of passive cracks and cracks requiring structural repair in walls shall be as follows:
   a. Crack widths less than 1/8 inches shall be pressure injected with epoxy resin adhesive.
2. Method 2: Repair of passive cracks and cracks requiring structural repair in slabs shall be as follows:
   a. Cracks widths less than 1/8 inches may be pressure injected with epoxy resin adhesive or gravity fed with epoxy penetrating sealant in accordance with MPII.
3. Method 3: Repair of active, non-structural cracks, cracks that exhibit leakage, or as directed by Engineer shall be as follows:
   a. Crack widths less than 1/8 inches shall be pressure injected with polyurethane sealant.
4. Method 4: Repair of active cracks requiring structural repair shall be as follows:
   a. Crack widths less than 1/8 inches shall be pressure injected with epoxy resin adhesive.
   b. Inject crack where crack is widest, as measured at concrete surface during one, 24 hour period.
5. Method 5: Very narrow crack (less than 0.010 inches wide) may be treated with silane sealer when directed by Engineer and approved by material manufacturer for the intended application.
6. Crack widths greater than 1/8 inches will be further investigated by Engineer and direction furnished to Contractor on repair method(s) required.

3.2 PREPARATION

A. Remove loose matter, dirt, dust, laitance, oil, grease, salt, and other contaminants from surfaces of cracks.

B. Clean cracks in accordance with the crack repair product MPII.

C. Clean surfaces adjacent to cracks, for not less than 1 inch on each side of each crack, to remove loose matter, dirt, dust, laitance, oil, grease, salt, and other contaminants that may be detrimental to bond of surface seal.

D. Do not use cleaners that will or have potential to adversely affect the repair.

3.3 EQUIPMENT USED FOR CRACK REPAIRS

A. Gauges:

1. Use properly-calibrated gauges, with current calibration, with pump and injection hose used for introducing material into cracks. Provide additional gauges at the Site to replace gauges that malfunction.

B. Pump:

1. Pump equipment used for pressure injection of material into cracks shall be suitable for the intended use and compatible with injection resin used.
2. Portable, positive displacement-type pump with interlock providing inline mixing and metering for two-component injection resins.
3. Where volume of crack repair is less than one quart for 1000 square feet of gross repair area, or where excessive grout pressure developed by pump might further damage structure, pre-mixed material and hand cartridge pumps may be used if acceptable to Engineer.
4. Pump may be electric-powered or air-powered with interlocks providing, at the nozzle, positive ratio control of proportions for the two components.
5. Use a primary injection pump for each material of different mix ratio. Also have available at the Site standby backup pump of similar ratio.
6. Capable of immediately compensating for changes in resins.
7. Do not use batch mix pumps.
8. Provide pressure hoses and injection nozzle for proper mixing of two adhesive components of epoxy resin adhesive.

C. Discharge Pressure Control:

1. Use automatic pressure controls capable of discharging mixed resin adhesive at pressures up to 190 to 210 psi, that maintain required pressure within range indicated in this paragraph.

D. Automatic Shutoff Control:

1. Provide and use sensors on both components for epoxy resin adhesive reservoirs for stopping pump automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance:

1. Maintain resin adhesive manufacturer's prescribed mix ratio within a tolerance of plus or minus 5% by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Use two independent, valved nozzles capable of controlling flow rate and pressure by opening or closing valve as necessary to restrict material flow.
2. Pressure gauge capable of sensing pressure behind each valve.

3.4 APPLICATION

A. Environmental Conditions:

1. Comply with material manufacturers’ written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation, and other conditions affecting performance of concrete crack repair products.
2. Substrate surface and ambient air temperature shall be between 40 and 90 degrees F for not less than 24 hours after application.

3. Pre-condition components to temperature of 70 degrees F for 24 hours immediately prior to installation, unless otherwise required in MPII.
4. Allow surfaces to attain temperature and conditions required before application.

B. Pressure Injection:

1. Use repair methods and equipment in accordance with Articles 3.1 and 3.3 of this Section. Use of caulk guns to fill cracks is unacceptable.
2. Drilling and Installing Injection Ports:
   a. Drill injection holes on each side of crack at a 45-degree angle to concrete surface.
   b. Provide holes at locations so that holes intersect crack at the approximate midpoint of crack depth. Holes shall extend through the crack section.
   c. Size of holes shall accommodate injection ports.
   d. Spacing of Injection Ports:
      1) Spacing between injection port holes shall not exceed the lesser of: depth of crack, 8 inches, or thickness of concrete member. Injection port holes shall be alternated from one side of crack to the other side of the crack.
      2) Space injection ports closer together to allow adjustment of injection pressure for minimum loss of resin to soil at locations where:
         a) Cracks extend entirely through wall.
         b) Backfill of walls on one side.
         c) Difficult to excavate behind wall to seal both crack surfaces.
   e. Prior to installing injection ports, clean each hole of deleterious material by air-water blast to completely remove drill cuttings from hole.
   f. Install and seal around each injection port with surface seal material in accordance with material MPII.
      1) Inserted end of injection port shall not extend beyond point at which drilled hole intersects the crack.
3. Cleaning and Flushing:
   a. After injection ports are inserted and sealed, flush crack with air-water mixture, or alternating water and air flush, to remove deleterious materials prior to injection of resin.
   b. Inject flushing media (air and water) through injection ports. Continue flushing until flushing media discharges from adjacent injection port and the crack is thoroughly cleaned.
   c. Perform final flush with air only to remove remaining water.
4. Surface Sealing:
   a. Provide surface seal in accordance with MPII to faces of all accessible cracks prior to pressure injecting.
   b. Seal surfaces of crack to prevent escape of injection resin.
5. Injection:
   a. Comply with material MPII and manufacturer's technical representative for mixing and injecting procedures.
   b. Commence injecting resin starting with injection port at crack's lowest elevation.
   c. Proceed upward along the crack, injecting resin through each successive injection port, without interruption, to the crack's highest elevation.
   d. Do not relocate injection nozzle to adjacent injection port until resin appears at the next-higher adjacent injection port or refusal criteria is developed.
   e. Seal each injection port immediately after completing the injection at that injection port.

C. Gravity Feed:

1. Provide epoxy penetrating sealant in accordance with material MPII.

3.5 CLEANING

A. Removal of Crack Seals at Pressure-Injected Cracks:

1. After completion of pressure injecting cracks in a given work area, remove surface seal material and re-finish concrete in area of pressure injection to match finish of existing, adjacent concrete.
2. Comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects regarding finishing requirements.
3. Do not perform surface finishing until curing period, as specified by material MPII, is complete.

B. Cleaning:

1. Clean and properly dispose of excess materials.
2. Avoid creation of nuisances.
3. Comply with Section 01 74 00 - Cleaning.

3.6 FIELD QUALITY CONTROL

A. Field Tests:

1. Monitor each pressure injection location. Observe and record the following:
   a. Volume of resin used within each 10 feet of crack length.
   b. Pump gauge pressure at intervals of not more than 10 minutes while material is being pumped.
   c. Indication of crack location and number, injection port spacing, and confirmation of resin appearing or refusal at each injection port.
2. Epoxy Resin Adhesive Two-Component Ratio Tests:
   a. Perform ratio test for each injection unit at beginning and end of each injection work day, and when injection work is stopped for more than one hour.
   b. Document and maintain complete, accurate records of ratios and pressure checks.
   c. Disconnect mixing head and pump two adhesive components simultaneously through ratio check device.
   d. Adjust discharge pressure to 160 psi for both adhesive components.
   e. Simultaneously discharge both adhesive components into separate calibrated containers.
   f. Compare amounts simultaneously discharged into calibrated containers during same period, to determine mix ratio.
   g. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
3. Injection Pressure Test:
   a. Perform injection pressure test for each injection equipment unit:
      1) At start and end of each injection work day.
   b. When injection work is stopped for more than 45 minutes Disconnect mixing head of injection equipment and connect two adhesive component delivery lines to pressure check device.
   c. Pressure Check Device:
      1) Two independent, valved nozzles capable of controlling flow rate and pressure.
      2) Pressure gauge capable of sensing and displaying pressure behind each valve.
   d. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.

   Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within three minutes.

   e. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

4. Crack Injection Tests (Structural Crack Repairs Only):
    a. Perform crack injection testing on structural crack repairs, when required by Engineer.
    b. Engineer may reduce the frequency of crack injection tests at Engineer's sole discretion.

B. Suppliers' Services:
1. Manufacturers of crack repair materials shall:
    a. Furnish required materials and services of manufacturer's representative at the Site.
    b. Review preparation and installation by Contractor and entity performing crack repair Work.
    c. Certify the installation methods to be used for each repair material used in the crack repair Work of this Section.
    d. Certify the installers and applicators of crack repair materials, if documentation of such prior certification was not previously furnished as a Submittal prior to starting the Work.
2. Manufacturers' representatives of crack repair materials shall be at the Site prior to and during first installation of the materials furnished under this Section to review preparation, field quality control, and proposed installation methods.

END OF SECTION

DIVISION 04

MASONRY

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SECTION 04 01 20
MASONRY CLEANING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Masonry cleaning.

B. Related Sections include but are not necessarily limited to:

1. Section 04 22 00 - Concrete Masonry.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Use experienced workmen familiar with product and its application.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Manufacturer's application instructions.
   b. Manufacturer's dilution recommendations.
   c. Manufacturer's recommendations on neutralizing rinse.

B. Certifications:

1. Certification that Contractor is experienced in this type of masonry cleaning.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Cleaning solution, detergent type:
   a. PROSOCO, Inc.
   b. Diedrich Technologies, Inc.
2. Cleaning solution for manganese or vanadium stained masonry:
   a. PROSOCO, Inc.
   b. Diedrich Technologies, Inc.

2.2 MATERIALS

A. Detergent-Type Cleaning Solution: PROSOCO, Inc. "Sure Klean #600 inches detergent masonry cleaner.

B. Manganese or Vanadium-Stained Masonry: PROSOCO, Inc. "Vanatrol."

C. Water: Potable.

D. Neutralizing rinse as required by manufacturer.

2.3 MIXES

A. Dilute cleaning solution with potable water at rate which will provide for the weakest solution allowable for cleaning wall.

B. If project conditions require solution of greater than 5% acid, obtain permission from Engineer in writing prior to applying solution to wall surface.

PART 3 - EXECUTION

3.1 PREPARATION

A. Allow seven days after completion of masonry work before start of cleaning.

B. Remove excess mortar using wooden paddles and scrapers.

C. Protect adjacent surfaces not to be cleaned.

3.2 APPLICATION

A. Protect adjacent surfaces subject to potential damage by cleaning solution.

B. Apply masonry cleaner to exposed-to-view masonry surfaces.

1. Do not use wire brushes.
2. Use only tools free of rust.
3. Apply solution using fibered wall-washing brush.

C. Thoroughly rinse and pre-soak walls.

D. Flush all loose mortar and dirt from surface.

E. Wet to prevent "run-off" streaking.

F. Scrape off mortar and reapply cleaning solution.

G. After scrubbing, clean thoroughly with pressurized water.

H. Apply neutralizing rinse as recommended by manufacturer.

END OF SECTION

SECTION 04 05 13
MASONRY MORTAR AND GROUT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Masonry mortar.
2. Masonry grout.
3. Integral water repellent admixture.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 31 30 - Concrete, Materials and Proportioning.
2. Section 04 22 00 - Concrete Masonry.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   b. C144, Standard Specification for Aggregate for Masonry Mortar.
   c. C150/C150M, Standard Specification for Portland Cement.
   d. C207, Standard Specification for Hydrated Lime for Masonry Purposes.
   e. C270, Standard Specification for Mortar for Unit Masonry.
   f. C404, Standard Specification for Aggregates for Masonry Grout.
   g. C476, Standard Specification for Grout for Masonry.
   h. C1019, Standard Test Method for Sampling and Testing Grout.
   i. C1093, Standard Practice for Accreditation of Testing Agencies for Masonry.
   j. C1384, Standard Specification for Admixtures for Masonry Mortars.
2. The Masonry Society (TMS):
   a. 602, Specification for Masonry Structures.

B. Qualifications:

1. Preconstruction Testing Laboratory shall be an independent agency qualified in accordance with ASTM C1093 for performing the testing indicated.
   a. Testing Laboratory shall have a minimum of 10 years of experience in the testing of mortar and grout.
   b. Technician conducting tests shall have minimum of five years of experience in the testing of mortar and grout.

C. Mock-Ups:

1. Provide mortar and grout for mock-up specified in Specification Section 04 22 00.

1.3 DEFINITIONS

A. Coarse grout and fine grout are defined by the aggregate size used in accordance with ASTM C476.

B. Coarse aggregate and fine aggregate are defined in ASTM C404, Table 1.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. General:
        1) Product data for cementitious materials.
        2) Source or producer of aggregates and gradation.
        3) Integral water repellent manufacturer's dosage rate.
    c. Proposed mortar mix design:
    d. Proposed masonry grout mix design.
2. Test results:
    a. Preconstruction mortar test results.
    b. Preconstruction masonry grout test results.

B. Informational Submittals:
1. Qualifications of testing lab and technician.
2. Test results and inspection reports per Specification Section 01 45 33.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location.
1. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

C. Deliver preblended, dry mixes in moisture-resistant containers.
1. Store preblended, dry mixes in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland Cement:
1. ASTM C150/C150M, Type I or II.
2. No air entrainment.
3. Natural color.
4. Maximum percent of alkalis: 0.60 in accordance with ASTM C150/C150M, Table 2.

B. Hydrated Lime:
1. ASTM C207, Type S.
2. Type SA not acceptable.
3. Lime substitutes are not acceptable.

C. Mortar Aggregate: ASTM C144, free of gypsum.

D. Grout Aggregate: ASTM C404.

E. Water: Potable.

F. Integral Water Repellent Admixture:
1. Liquid polymeric admixture: ASTM C1384.
2. Verify compatibility with liquid water repellent admixture being used in the fabrication of concrete masonry units.

2.2 MIXES

A. Mortar and grout shall comply with TMS 602 and building code.

B. Type "S" mortar shall be used:

1. Comply with ASTM C270, Table No. 1, Cement-Lime Mortar.
   a. Do not use masonry cement or mortar cement.
   b. No fly ash additives will be accepted.
2. Mix materials minimum of three minutes and maximum of five minutes.
3. Adjust consistency to satisfaction of mason.
4. Do not use admixtures unless otherwise indicated.
5. Provide integral water repellent admixture in mortar used for:
   a. Exterior concrete masonry work.
   b. Interior concrete masonry work in wet areas.
6. Do not use integral water repellent admixture in mortar for brick.

C. Masonry Grout:

1. ASTM C476.
   a. Minimum 28-day compressive strength: 2,000 psi.
   b. Slump: 8 to 11 inches.
2. Mix 5 minutes minimum.
3. No admixtures allowed.
4. At Contractor's option, premixed or preblended grout meeting the above minimum requirements may be used.

2.3 SOURCE QUALITY CONTROL

A. Perform preconstruction laboratory tests on proposed masonry mortar and grout prior to start of masonry work.

1. Perform tests far enough in advance so that any necessary retesting can be accomplished before masonry construction begins.
   a. Test mortar per ASTM C270.
   b. Test grout per ASTM C1019.

B. Source Limitations for Mortar Materials:

1. Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and TMS 602.

B. Mortar:

1. If standard gray mortar begins to stiffen, it may be retempered by adding water and remixing unless prohibited by water repellent admixture manufacturer.
   a. Standard gray mortar shall not be retempered more than one time.
2. All mortar must be used within 2-1/2 hours maximum after initial mixing per TMS 602.
3. Engineer reserves right to alter mix design based on initial rate of absorption of masonry units.

C. Masonry Grout:

1. Use grout within 1-1/2 hours maximum after initial mixing.
2. Use no grout after it has begun to set.
3. Do not retemper grout after initial mixing.

4. Place grout in lifts not exceeding 4 feet.
5. Use coarse grout in spaces with least dimension over 2 inches.
6. Consolidate all grout while installing.
   a. Consolidate grout pours 12 inches or less in height by mechanical vibration or by puddling.
   b. Consolidate grout pours exceeding 12 inches in height by mechanical vibration and reconsolidate by mechanical vibration after initial water loss and settlement has occurred.

3.2 FIELD QUALITY CONTROL

A. Masonry Mortar and Grout Testing and Inspection:

1. Testing and inspection services will be provided by the Owner's special masonry inspector.
   a. Do not include in the bid price the cost of these services.
2. Testing and inspection shall include, but is not limited to:
   a. Observe proportions of site-prepared mortar and grout.
   b. Observe grout space prior to grouting.
   c. Grout compressive strength sampling, testing and reporting per ASTM C1019.
      1) One strength test shall be the average of three specimens from the same sample, tested at 28 days.
   d. Grout slump test sampling, testing, and reporting per ASTM C143/C143M.
   e. Frequency of sampling: One sample (three specimens) collected each grouting operation during masonry construction.
3. Reporting: Special inspector to submit test results and inspection reports per Specification Section 01 45 33.

END OF SECTION

SECTION 04 05 23
MASONRY ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Masonry accessories.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 04 22 00 - Concrete Masonry.
2. Section 05 50 00 - Metal Fabrications.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A951, Standard Specification for Steel Wire for Masonry Joint Reinforcement.
   c. A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
   d. A1064, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

B. Mock-Ups:

1. Provide specified products for inclusion into mock-up panels required by Specification Section 04 22 00.
2. Coordinate with built-in items and veneer coursing.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Tear resistance of flashing material.
   d. Manufacturer's recommendations for flashing adhesive.
   e. Manufacturer's data sheet on each product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Weep vents for cavity wall construction:
   a. Heckman Building Products Inc.
   b. Hohmann & Barnard, Inc.
   c. Wire Bond.
   d. Mortar Net USA, Ltd.
2. Masonry anchors, horizontal joint reinforcing and miscellaneous anchors:

a. Heckman.
b. Hohmann & Barnard, Inc.
c. Wire Bond.

3. Weep joint mortar protection system:
   a. Mortar Net USA, Ltd.
   b. Hohmann & Barnard, Inc.
   c. Wire Bond.
4. Preformed control joint inserts:
   a. Hohmann & Barnard, Inc.
   b. Wire Bond.
5. Grout screen:
   a. Wire Bond.
   b. Heckman Building Products.
   c. Hohmann & Barnard, Inc.

2.2 MANUFACTURED UNITS

A. Flashing Adhesive: As recommended by flashing manufacturer for sealing laps, sealing to vertical masonry and concrete surfaces and sealing to stainless steel surfaces.

B. Weep Vent:
   1. 90% open mesh vent designed to be placed in vertical mortar joint.
   2. Mortar Net USA, Ltd. "Mortar Net Weep Vents."
   3. Color: Gray.

C. Horizontal Joint Reinforcing:
   1. General:
      a. Conform to ASTM A951.
      b. Cold drawn steel wire, ASTM A82.
      c. 9 GA side rods.
      d. 9 GA cross rods.
      e. Hot-dipped galvanized, ASTM A153/A153M.
      f. Prefabricated corner and tee sections with minimum length of 30 inches from point of intersection.
   2. Single wythe wall joint reinforcing: Ladder design.
   3. Composite wall joint reinforcing: Ladder design with double side rod.
   4. Cavity wall joint reinforcing with masonry back-up:
      a. Ladder design horizontal joint reinforcing.
      b. Wire eyes welded to horizontal joint reinforcing.
         1) Length as necessary to project through rigid insulation into airspace.
      c. 3/16 inches diameter adjustable pintle veneer anchors.
         1) Length as necessary to provide minimum 2 inches embed into veneer mortar joint.
      d. Hohmann & Barnard "270 Ladder."

D. Rigid Steel Masonry Anchors:
   1. 1 inches by 1/4 inches with ends turned up 2 inches.
   2. Hot-dipped galvanized steel, ASTM A153/A153M.
   3. Length:
      a. 24 inches unless noted otherwise.

b. Where wall conditions such as jambs or other obstructions preclude the use of 24 inches anchors, shorter anchors may be used.

E. Mesh Wall Ties:

1. Hot-dipped galvanized steel, ASTM A153/A153M.
2. 16 GA, 1/2 inches square mesh.
3. Width: 2 inches less than nominal wall thickness.
4. Length: As necessary to embed minimum 6 inches into each wall.

F. Grout Screen:

1. Polypropylene monofilament.
2. 1/4 x 1/4 inches mesh.
3. Width of grout screen to be 2 inches less than nominal width of CMU.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Butt joints of preformed control joint inserts tightly together and secure with adhesive or sealant acceptable to insert manufacturer.

C. Reinforcing Masonry:

1. General:
   a. Provide continuous horizontal joint reinforcing in all concrete masonry wall construction.
      1) Embed longitudinal side rods in mortar for entire length with minimum cover of 5/8 inches on exterior side of walls and 1/2 inches at other locations.
         a) For interior partitions, the "exterior" side of the wall is considered the side having the most corrosive atmosphere or the corridor side of the wall.
      2) Lap reinforcement minimum of 12 inches at ends.
         a) Remove cross wires on one side of the lap splice and bend the side rods slightly so the lap is provided with 12 inches of uninterrupted wire lap occurring in the same plane.
      3) Do not bridge control joints with horizontal joint reinforcing.
      4) Do not bridge expansion joints with horizontal joint reinforcing.
      5) At corners and wall intersections use prefabricated "L" and "T" horizontal joint reinforcing sections.
      6) Cut and bend as necessary.
   b. Install reinforcing at 16 inches on-center vertically unless noted otherwise on Drawings.
   c. Install reinforcing 8 inches on-center vertically for a minimum of 24 inches at starter courses.
      1) Do not install horizontal joint reinforcing in veneer mortar joint having through-wall flashing.
   d. In concrete masonry, install additional horizontal joint reinforcing 16 inches on-center in courses on each side of vertical control joints and on each jamb of openings for full height of joint or opening.
      1) Alternate with normal wall horizontal joint reinforcing.
      2) Extend reinforcing minimum 32 inches beyond joint or jambs of opening.
   e. In concrete masonry, reinforce masonry openings over 12 inches wide with horizontal joint reinforcing placed in three horizontal joints above lintel and two horizontal joints below sill.
      1) Extend minimum of 32 inches beyond jambs of opening.

2. Reinforcing concrete masonry:
   a. Install reinforcing bars where indicated on Drawings.
      1) Provide means necessary to ensure position of vertical steel reinforcing meets requirements of the building code.
   b. At intersecting load-bearing walls, provide rigid steel anchors 16 inches on-center vertically, embed ends in grout filled cores.
      1) Alternate rigid steel anchors with horizontal joint reinforcing.
   c. At intersecting non-load bearing walls or at intersecting load bearing/non-load bearing walls provide mesh wall ties in mortar joint at 16 inches on-center vertically.
      1) Extend minimum 6 inches into each wall.
      2) Alternate mesh wall ties with horizontal joint reinforcing.
   d. Anchor intersecting concrete masonry to intersecting cast-in-place or precast concrete using dovetail slots and anchors.
      1) Provide dovetail anchors at 16 inches OC or as noted on Drawings.
3. Repair all galvanized coatings damaged as a result of welding.
   a. See Specification Section 05 50 00 for galvanizing repair system.

END OF SECTION

SECTION 04 05 50
COLD AND HOT WEATHER MASONRY CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold weather protection.
2. Hot weather protection.

B. Related Specification Sections include but are not necessarily limited to:

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Brick Industry Association (BIA):
   a. Technical Note 1, Cold and Hot Weather Construction.
2. National Concrete Masonry Association (NCMA).
   a. TEK 3-1C, All Weather Concrete Masonry Construction.
3. The Masonry Society (TMS):
   a. 602, Specification for Masonry Structures.

1.3 DEFINITIONS

A. As defined in TMS 602.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 ERECTION AND APPLICATION

A. General:

1. Comply with NCMA TEK 3-1C and BIA Tech Note 1 recommendations and practices.
2. Do not use frozen or ice coated materials.
3. At end of each day or at shutdown, cover tops of all walls not enclosed or sheltered with clear polyethylene minimum 6 mil thick.
   a. Extend down each side of wall minimum of 16 inches and secure.

B. Temporary Facilities:

1. Construct and maintain temporary protection required to permit continuous and orderly progress of work.
2. Provide and maintain heat sufficient to assure temperature above 32 degrees F within protected areas.
3. Remove all temporary facilities after completion of work.

C. Cold Weather Construction and Protection Requirements:

1. Prior to and during installation:
   a. Air temperature 32 to 40 degrees F: Heat mixing water or aggregate to produce mortar temperatures between 40 and 120 degrees F.
   b. Air temperature 25 to 32 degrees F:
      1) Heat mixing water or aggregate to produce mortar temperatures between 40 and 120 degrees F.
      2) Maintain mortar temperatures above freezing until used.

c. Air temperature below 25 degrees F:
    1) Heat mixing water and aggregate to produce mortar temperatures between 40 and 120 degrees F.
    2) Maintain mortar temperatures above freezing until used.
    3) Maintain temperature of units until laid at not less than 40 degrees F.
    4) Provide heat on both sides of walls under construction to maintain air temperature above freezing.
    5) Provide windbreaks or shelters when wind is in excess of 15 mph.
        a) Wind breaks or shelters shall be translucent.

2. After installation:
    a. Air temperature 32 to 40 degrees F: Protect from rain or snow for not less than 24 hours by covering with weather-resistive translucent membrane.
    b. Air temperature 25 to 32 degrees F: Completely cover with translucent weather-resistive membrane for not less than 24 hours.
    c. Air temperature 20 to 25 degrees F: Completely protect with insulating blankets for not less than 24 hours or provide other protection approved by Engineer.
    d. Air temperature below 20 degrees F:
        1) Provide enclosed translucent shelters and heating to maintain air temperature on each side of wall above 32 degrees F for 24 hours.
        2) Do not allow rapid drop in temperature after removal of heat.
    e. Promptly repair all tears, holes, etc., to translucent membrane and shelter using compatible patching material and tape as recommended by membrane manufacturer.

D. Hot Weather Construction and Protection Requirements:
1. Comply with requirements of NCMA, BIA and TMS 602.
2. Storage and preparation of materials.
    a. Cover or shade masonry units and mortar materials from direct sun.
    b. Maintain sand in a damp loose condition.
        1) Sand moisture shall be maintained at minimum 8%.
        2) Sprinkle with cool water as required to maintain moisture content.
    c. Use cool water for mixing mortars.
    d. Avoid using tools and equipment that have been sitting in the sun.
        1) Sprinkle mortar boards, mortar pans, wheelbarrows, mixers, etc., with cool water.
    e. Do not wet concrete masonry units prior to use.
3. Installation:
    a. Place masonry units within one minute of the spreading of the mortar.
        1) Mortar beds shall not be spread more than 4 feet ahead of the masonry unit being placed.
    b. Provide wind screens and shading partitions as required to eliminate direct sunlight exposure.
    c. Wet installed units using fog spray of clean water.
    d. Cover installed work immediately after installation to slow rate of loss of moisture from units.
    e. Fog-spray new masonry work until damp.
        1) Repeat fog spraying minimum of three times per day until masonry work has cured for 72 hours.

2) In high humidity conditions, Engineer reserves the right to discontinue fog spraying if operation is found to be introducing excessive amounts of moisture into the Work.

END OF SECTION

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SECTION 04 22 00
CONCRETE MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete masonry construction (CMU), including:
   a. Standard concrete masonry.
   b. Pre-colored masonry.
   c. Split-face masonry.
   d. Precast concrete lintels.
2. Integral water repellent admixture.
3. Masonry special inspection.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 21 00 - Reinforcement.
2. Section 03 31 30 - Concrete, Materials and Proportioning.
3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
4. Section 04 01 20 - Masonry Cleaning.
5. Section 04 05 13 - Masonry Mortar and Grout.
6. Section 04 05 23 - Masonry Accessories.
7. Section 04 05 50 - Cold and Hot Weather Masonry Construction.
8. Section 07 21 00 - Building Insulation.
9. Section 07 92 00 - Joint Sealants.

1.2 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
   a. Terminology used in this Section are in accordance with “Standard Unit Nomenclature” Table 1, NCMA TEK 2-3A.

B. Reference Standards:

1. ASTM International (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C55, Standard Specification for Concrete Building Brick.
   c. C90, Standard Specification for Loadbearing Concrete Masonry Units.
   d. C426, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.
   e. C1357, Standard Test Methods for Evaluating Masonry Bond Strength.
   f. E514, Standard Test Method for Water Penetration and Leakage Through Masonry.
2. National Concrete Masonry Association (NCMA):
   a. TEK 2-3A, Architectural Concrete Masonry Units.
   b. TEK 3-4B, Bracing Concrete Masonry Walls During Construction.
   c. TEK 8-2A, Removal of Stains from Concrete Masonry.
   d. TEK 8-3A, Control and Removal of Efflorescence.
3. The Masonry Society (TMS):
   a. 602, Specification for Masonry Structures.

1.3 QUALITY ASSURANCE:

A. Regulatory Requirements:

1. Applicable construction codes including building code are indicated in Section 01 42 00 - References.

B. Qualifications:

1. Concrete masonry unit manufacturer shall be licensed or qualified, in writing, by manufacturer of integral water repellent admixture to produce masonry units containing manufacturer's admixture.
   a. Concrete masonry unit manufacturer shall have not less than five years experience manufacturing masonry units containing admixture manufacturer's products.
2. Testing laboratory shall have a minimum of 10 years experience in the testing of concrete masonry units using the method(s) specified.
3. Technician conducting tests shall have a minimum of five years experience in the testing of concrete masonry units using the method(s) specified.

C. Mockups:

1. Mockups – General: Prior to permanent wall construction, construct mockup.
   a. Construct mockup on a concrete footing as necessary to demonstrate construction details.
      1) Minimum slab thickness: four inches.
   b. Mockup shall show full color range, texture and bond pattern(s) of each type masonry required.
   c. Size: As large as necessary to properly display all conditions required by masonry construction.
      1) Not less than four feet high by eight feet long.
         a) Return corners and intersections not less than four feet.
      2) Mockup shall demonstrate:
         a) Outside corner condition.
         b) Inside corner condition.
         c) Jamb condition demonstrating lintel bearing and flashing.
         d) Masonry control joint.
   d. Include all special corners and other special CMU detailing shown on the Drawings.
   e. Include all types of masonry shown on the Drawings, including:
      1) Pre-colored masonry.
      2) Split-face masonry.
      3) Precast lintel.
      4) Brick masonry.
   f. Mockup shall include:
      1) Each type of masonry required for the Work.
         a) Each type of special shape.
         b) Each type of back-up wall system(s).
      2) Vertical wall reinforcing with grouted cell.
      3) Typical bond beam construction.
      4) Typical lintel construction.
      5) Positioning, securing and lapping of reinforcing steel.
      6) Masonry accessories:
         a) Horizontal joint reinforcing.
            (1) Positioning and lapping of joint reinforcing.

b) Veneer anchorage system(s).
c) Thru wall flashing and drip edge.
(1) Demonstrate inside and outside corner conditions showing thru wall flashing lapping, jointing and sealing.
d) Weep joint mortar protection system.
e) Weep joints and weep vents.
f) Typical control joint construction.
g) Mesh wall ties.
h) Rigid steel masonry anchors.
7) Insulation.
8) Cleaning of masonry work.
2. Step construction of mockup to allow observation of components.
3. Following acceptance of mockup by Engineer, shall constitute minimum standard of quality for the Work.
a. Maintain and safeguard mockup until Substantial Completion.
4. If not acceptable as determined by Engineer, provide additional mockups as necessary.
5. Remove mockups when directed by Engineer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Scaled (minimum 1/8 inches per foot) plans showing proposed locations of masonry control joints.
b. Wall elevations and sections, indicating special shapes, shape part numbers, applicable dimensions.
c. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, masonry cover, and reinforcing supports.
1) Reference Section 03 21 00 for additional requirements.
d. Detail drawings for:
1) Precast concrete lintels.
a) Show profiles, cross-sections, reinforcement and steel components.
2. Product Data:
a. Manufacturer's information on aggregate and cement type used in manufacture.
b. Data sheet on each type of masonry unit required, including:
1) Pre-colored masonry.
2) Split-face masonry.
c. Data sheets on integral water repellent admixture being used in masonry unit manufacturing.
d. Technical bulletins on cleaning masonry containing integral water repellent.
3. Samples:
a. Concrete Masonry Finish Samples: Manufacturer's complete offering of colors and textures for each type of masonry required.
1) Not less than three inches by three inches Samples for initial selection by Engineer, in consultation with Owner.
2) Submit two, Samples, each eight inches by eight inches, of each type of masonry selected, for final approval by Engineer, in consultation with Owner.
3) Samples of standard gray-colored masonry are not required.

B. Informational Submittals: Submit the following:

1. Certifications:
    a. Certification that concrete masonry units meet or exceed requirements of standards referenced.
    b. Certification that fire-resistive rated units meet the requirements of applicable building code.
    c. Certification that integral water repellent admixture will not affect the use of coloring processes or alter actual colors of factory colored masonry units.
    d. Certification of integral water repellent admixture dosage rates from concrete masonry unit Supplier.
    e. Concrete masonry Supplier shall certify that integral liquid water repellent admixture was furnished at dosage rate recommended by admixture manufacturer for use in exterior (outdoor) wall construction.
2. Supplier Instructions:
    a. Instructions for handling, storing, and installation.
3. Source Quality Control Submittals:
    a. Results of tests, inspections, and other quality control activities required by the Contract Documents and performed at the place of production or fabrication.
4. Field Quality Control Submittals:
    a. Results of tests, inspections, and other quality control activities required by the Contract Documents and performed at the Site.
5. Qualifications:
    a. Supplier of masonry units when requested by Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements:
    1. Inspect units upon delivery, to verify color match with mockup or approved samples, dimensional quality, and trueness of unit.

B. Storage and Handling Requirements:
    1. Covering material shall be weather-proof but vapor permeable to prevent accumulation of moisture under cover.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Standard masonry units:
        a. Any manufacturer capable of meeting the requirements of this Specification Section.
    2. Integral water repellent admixture:
        a. GCP Applied Technologies, Inc.
        b. ACM Chemistries, Inc.

2.2 MATERIALS

A. Cement: Type I or II Portland, ASTM C150.

B. Aggregate: ASTM C33.

C. Reinforcing Bars: Refer to Section 03 21 00.

D. Mortar: Refer to Section 04 05 13.

E. Masonry Grout: Refer to Section 04 05 13.

F. Masonry Accessories: Refer to Section 04 05 23.

G. Insulation: Refer to Section 07 21 00.

H. Sealants: Refer to Section 07 92 00.

I. Integral Concrete Masonry Water Repellent:

1. Liquid polymeric admixture.
2. GCP Applied Technologies, Inc., "DRY-BLOCK".

2.3 MANUFACTURED UNITS

A. General:

1. Masonry units of each type, color, or face style shall be from a single production run by Supplier.
2. Factory fabricate special shapes unless otherwise required.
3. Fire resistive units: Fabricate to comply with applicable building code.
4. Fabricated in manufacturing facility.
5. Provide square corners unless required otherwise.

B. Concrete Masonry Units:

1. Modular units: ASTM C90.
   a. Normal weight units: Minimum of 125 pound/cubic foot.
   b. Light weight or medium weight units are not acceptable.
2. Concrete bricks:
   a. Structural units: ASTM C55.
      1) Same material, texture and density as modular units.
3. Color:
   a. Interior units: Standard gray.
   b. Exposed exterior units: Standard gray, _____.
4. Design compressive strength: f'm= 2,000 PSI minimum.
   a. Determine in accordance with TMS 602.
      1) Unit strength method, sampled and tested in accordance with ASTM C140.
      2) Prism test method.
5. Provide masonry units manufactured with integral water repellent admixture for the following exposures:
   a. Exterior veneer.
   b. Exterior single-wythe construction.
   c. Exterior composite wall construction.
   d. Interior areas defined as wet and/or corrosive.
      1) See Specification Section 07 92 00 for definition of wet and/or corrosive areas.
6. Special shapes and faces:
   a. Corner units.
      1) Corner units used in veneer wythe shall have a finished return leg one-half the length of a standard modular stretcher unit.
      2) Corner units shall maintain regular modular masonry coursing.
   b. Finished end units.
   c. Split face.Other special shapes as indicated on Drawings or necessary to maintain coursing.

C. Precast concrete lintels:

1. Concrete: See Specification Section 03 31 30 and 03 31 30.
2. Reinforcing: See Specification Section 03 21 00.

3. Embedded steel components: Galvanized.
   a. See Specification Section 05 50 00.

2.4 PERFORMANCE AND DESIGN REQUIREMENTS:

A. Integral Concrete Masonry Water Repellent:

1. Water permeance of masonry: Capable of achieving a Class E Rating when evaluated using ASTM E514 with the test extended to 72 hours, using the rating criteria specified in ASTM E514.
2. Flexural bond strength of masonry: An increase of 10%, minimum, in masonry flexural bond strength shall occur as a result of adding integral water-repellent concrete masonry and mortar admixtures when compared to a control (containing no admixtures) concrete masonry and mortar tested in accordance with ASTM C1357.
3. Compressive strength of masonry prisms: Maximum 5% decrease in compressive strength of prisms shall occur as a result of adding integral water-repellent concrete masonry and mortar admixtures when compared to a control (containing no mortar admixtures) concrete masonry and mortar when tested in accordance with ASTM C1314.
4. Drying shrinkage of masonry: Maximum 5% increase in drying shrinkage of the concrete masonry units shall occur as a result of adding integral water repellent concrete masonry admixture when compared to a control (containing no admixtures) concrete masonry when tested in accordance with ASTM C426.
5. Grout shear bond strength: Maximum 5% decrease in grout shear bond strength shall occur as a result of adding integral water repellent admixture to the concrete masonry units when compared to a control (containing no admixtures).

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that anchors and flashings are correct.

B. Lay out walls in advance for uniform and accurate spacing of bond patterns and joints.

1. Properly locate openings, movement type joints, returns, and offsets weep joints and weep vents.

3.2 INSTALLATION

A. General:

1. Build in flashing, reinforcing, weeps, weep vents and related accessory items.
   a. See Specification Section 04 05 23 for installation of accessory items.
2. Perform all cutting using masonry saw blades.
3. Drill holes using masonry drill bits or core drill.
   a. Holes made by chipping unit will not be accepted.
4. Install field units in running bond, unless noted otherwise.
   a. Provide special coursing where indicated on the Drawings.
5. Cut as required to maintain bond pattern.
6. Use solid units where cutting or laying would expose holes and as noted on Drawings.
7. Avoid use of less than half size units, whenever possible.
8. Do not use chipped, cracked, spalled, stained or imperfect units exposed in finish work.
9. Provide units of uniform color, within the range demonstrated on the approved mock-up.
10. Do not wet concrete masonry units.
11. Build chases and recesses as indicated and required for work of other trades.
    a. Provide not less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses unless detailed otherwise on the Drawings.

12. In fire-resistive rated wall construction, install fire resistive units in accordance with the building code.

B. Concrete Masonry Units:

1. Grout solid all cells containing steel reinforcing and as indicated on Drawings.
   a. Refer to Specification Section 04 05 13 for grouting.

C. Laying and Tooling:

1. Lay masonry units with completely filled bed and head joints.
   a. Provide full mortar bed on all block cross webs and completely fill head joints.
      1) Do not slush head joints.
      2) Protect cells requiring grout fill from mortar droppings.
      3) Omit mortar from head joint at weep joint opening.
2. Maintain nominal 3/8 inches joint widths.
   a. Cut joints flush where concealed.
   b. Tool exposed joints concave.
   c. Compress mortar in below ground joints and in joints concealed by insulation in cavity wall construction.
   d. Provide wider joints where noted on Drawings.
      1) In no case shall any mortar joint be more than 3/4 inches wide.
3. During tooling of joints, enlarge any voids or holes except weeps, and completely fill with mortar.
4. Point-up all joints at corners, openings, and adjacent work to provide neat, uniform appearance.
5. Remove masonry disturbed after laying.
   a. Clean and relay in fresh mortar.
   b. Do not pound units to fit.
   c. If adjustments are required, remove units, clean, and reset in fresh mortar.
6. Where work is stopped and later resumed, rack back 1/2 masonry unit length in each course.
   a. Remove loose units and mortar prior to laying fresh masonry.
7. As work progresses, build in items indicated on Drawings and specified.
   a. Fill in solidly with mortar around built-in items.
   b. Where built-in items are to be embedded in cores of hollow masonry units, place grout screen in joint below and fill core solid with mortar.

D. Control Joints and Sealants:

1. Provide vertical expansion, control and isolation joints where indicated on Drawings.
2. Where not indicated on Drawings, submit proposed control joint locations in accordance with the following requirements:
   a. Provide control joints at maximum 24 feet OC.
   b. Provide at all T intersections.
   c. Locate joints so as to allow lintels and bond beams above and below openings to extend beyond the opening as indicated on the Drawings without control joints thru the lintel or bond beam.
   d. Provide preformed rubber control joint inserts in accordance with Specification Section 04 05 23.
3. Rake out mortar in joint.
4. Refer to Specification Section 07 92 00 for sealant installation requirements.
   a. Seal control and expansion joints.

E. Tolerances:

1. Maximum variation from plumb in vertical lines and surfaces of columns, walls, and arises:
   a. 1/4 inches in 10 feet.
   b. 3/8 inches in a story height not to exceed 20 feet.
   c. 1/2 inches in 40 feet or more.
2. Maximum variation from plumb for external corners, expansion joints, and other conspicuous lines:
   a. 1/4 inches in any story or 20 feet maximum.
   b. 1/2 inches in 40 feet or more.
3. Maximum variation from level of grades for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
   a. 1/4 inches in any bay or 20 feet.
   b. 1/2 inches in 40 feet or more.
4. Maximum variation from plan location of related portions of columns, walls, and partitions:
   a. 1/2 inches in any bay or 20 feet.
   b. 3/4 inches in 40 feet or more.
5. Maximum variation in cross-sectional dimensions of columns and thicknesses of walls from dimensions shown on Drawings:
   a. Minus 1/4 inches.
   b. Plus 1/2 inches.
6. Maximum variation in mortar joint width:
   a. Bed joints: 3/32 inches in 10 feet.
   b. Head joints:
      1) Minus 1/8 inches.
      2) Plus 1/8 inches.

F. Protect against weather when work is not in progress.

1. During inclement weather conditions, cover top of walls with translucent waterproof membrane.
2. See Specification Section 04 05 50.

G. Protect against cold/hot weather as specified in Specification Section 04 05 50.

3.3 FIELD QUALITY CONTROL

A. Bracing Concrete Masonry Walls During Construction:

1. At a minimum, provide bracing in accordance with NCMA TEK 3-4B.
2. Contractor is responsible for adequately bracing all masonry during construction.

B. Remove and replace loose, stained, damaged and other unacceptable units as directed by Engineer.

1. Provide new units to match.
2. Install in fresh mortar.
3. Point to eliminate evidence of replacement.

C. Special Masonry Inspection:

1. See Specification Section 01 45 33 for special inspection general requirements.
2. Masonry inspection services will be provided during the following construction activities:
   a. Cost of masonry inspection services will be paid by Owner.
   b. During laying of units:

1) During the first day of the masonry construction, inspect proportions of site prepared mortar, construction of mortar joints, location of all reinforcing and connectors, size and location of structural elements, type, size and location of anchors, protection of masonry during cold weather.
2) Inspection to be continuous the first full day of masonry construction which requires special inspection.
   a) Thereafter, a minimum of 3 hours every third day of construction until the concrete masonry work is complete.
3) Inspection while laying masonry units may be made concurrently with other inspection duties provided all inspection duties are adequately performed.
4) When deficiencies are found, additional inspection shall be provided as required until deficiencies have been corrected.
5) If masonry crews change, an additional full day of inspection is required during the first day the new crew is on-site.

c. Placement of reinforcing steel:
   1) Verification of all reinforcing including size, grade, lap lengths, and type.
   2) Inspection may be periodic as required to verify all reinforcing.
   3) Inspector to be present during the concrete pour in which any dowels connecting concrete to masonry are cast.
      a) Inspector to verify proper location of dowels.

d. Prior to each grouting operation, verify that grout space is clean, reinforcing is clean and connectors are properly placed, proportions of site-prepared grout are correct and mortar joints have been properly constructed.
   1) Inspection may be periodic as required to verify proper grout space.

e. Verify compliance with building code and Specifications continuously during all grouting operations.

f. Provide special inspection in accordance with the TMS 602 Level B Quality Assurance including observation of masonry work for conformance to the Contract Documents:
   1) Provide inspection reports to the Engineer, Building Official and Owner.
      a) Notify Contractor of discrepancies for correction.
      b) Notify Engineer, Building Official and Owner, in writing, when discrepancies have been satisfactorily corrected.
   2) Submit final signed report stating that work requiring special inspection was, to the best of the inspector's knowledge, in conformance to the Contract Documents and the applicable workmanship previsions of the building code.

D. Performance Testing:
   1. Perform prism tests on concrete masonry units used in construction.
      a. Perform all specimen construction, testing and reporting per ASTM C1314.
      b. Perform tests on ungrouted prisms.
      c. Frequency of testing: One set of three prisms for each 4,000 block units or fraction thereof for each different type and/or thickness of block.
      d. Average compressive strength of three prisms tested at 28 days shall meet or exceed design strength.

3.4 CLEANING

A. Clean concrete masonry as the wall is being constructed using fiber brushes, wooden paddles and scrapers.
   1. Do not use metal tools or wire brushes.
   2. No acid-based cleaning solutions shall be used unless approved in writing by Engineer.

B. Remove dirt and stains in accordance NCMA TEK 8-2A.

C. Remove primary efflorescence in accordance with NCMA TEK 8-3A.

END OF SECTION

DIVISION 05

METALS

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SECTION 05 12 00
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel, including the fabrication and erection of support and bracing members, including connections.
2. Connection detail design as required.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 15 19 - Anchorage to Concrete.
2. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Institute of Steel Construction (AISC):
   a. 303, Code of Standard Practice for Steel Buildings and Bridges.
   b. 360, Specifications for Structural Steel Buildings.
   c. Quality Certification Program for Fabricators.
2. American Society of Mechanical Engineers (ASME):
   a. B18.21.1, Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
3. ASTM International (ASTM):
   a. A2, Standard Specification for Carbon Steel Girder Rails of Plain, Grooved, and Guard Types.
   b. A6/A6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   c. A36/A36M, Standard Specification for Carbon Structural Steel.
   d. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   e. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   f. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   i. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   j. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   k. A992/A992M, Standard Specification for Structural Steel Shapes.
   l. A1064/A1064M, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   m. F436, Standard Specification for Hardened Steel Washers.
   n. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
   o. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

p. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

4. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
   c. A5.17/A5.17M, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   d. A5.18/A5.18M, Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding.
   e. A5.20/A5.20M, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   f. A5.23/A5.23M, Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding.
   g. A5.28/A5.28M, Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding.
   h. A5.29/A5.29M, Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding.
   i. D1.1/D1.1M, Structural Welding Code - Steel.
      1) Steel stud connectors and their installation to comply with requirements of AWS D1.1/D1.1M.
5. National Institute of Steel Detailing (NISD).
6. Research Council on Structural Connections (RCSC):
   a. Specification for Structural Joints Using High-Strength Bolts.

B. Qualifications:
   1. Steel fabricator:
      a. Minimum of 5 years of experience in fabrication of structural steel or participate in the AISC Certification program and is designated an AISC Certified Plant, Category BU (formally known as STD), SBR at time of bid.
      b. Fabricator plant quality control and inspection program: Meet requirements of the building code and/or be an Approved Fabricator.
      c. Plants that are not an Approved Fabricator may be acceptable, provided:
         1) Plant meets all remaining qualifications.
         2) Contractor reimburses the Owner the cost of required Special Inspection services.
   2. Steel erector:
      a. Minimum of 5 years of experience in erection of structural steel similar in the scope of this project or certified as CSE under the AISC Quality Certification Program.
      b. With an active and enforced quality assurance program in place, as described in the applicable Codes.
   3. Qualify welding procedures and welding operators in accordance with AWS.

1.3 DEFINITIONS

A. Owner: May mean the Owner's Designated Representative for Construction as defined by the AISC 303.

B. Galvanizing: Hot-dipped galvanizing per ASTM A153/A153M and/or ASTM A123/A123M with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by aforementioned standards.

C. Approved Fabricator: Approved by the Building Official to perform the building code required Special Inspections.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Detailed supplemental specification relating to load indicator washers or high-strength bolts.
      1) Alternate design for Engineer approval (submitted at Contractor's option if desired by Contractor for use).
   d. Source and certification of quality for high-strength bolts, nuts and washers.
2. Fabrication and/or layout drawings:
   a. Prepare Shop Drawings under NISD Quality Procedures Program certification.
   b. Complete Shop Drawings for all of the work showing clearly all pieces, sizes, dimensions, details, connections materials and shop coatings.
      1) All Shop Drawings must be checked and signed "approved" before submittal.
      2) Show all cuts, copes, and holes.
      3) Indicate all shop and field bolts.
      4) Indicate all shop and field welds using AWS symbols.
   c. Prepare complete erection drawings showing the location and marks of all pieces.
      1) Copies of up-to-date erection drawings shall accompany the Shop Drawings.
      2) Use match marks on the erection drawings to indicate the sheet number on which each particular member is detailed.
   d. Correct any incorrect or unacceptable material or fabrication due to incorrect detailing, shop work, or erection, without additional charge.
3. Certifications:
   a. Certificates of compliance with standards specified for all major components and fasteners incorporated into work.
   b. Copies of current welding certificates for each welder assigned to perform welding indicating compliance with testing specified by AWS.
   c. Welder qualification data and prequalified procedures.
   d. Special Inspections reports.
   e. Source Quality Control Documentation, including certificate of compliance stating that the work performed in the fabrication shop was done in accordance with the approved construction documents.
      1) Certification is required only if the fabricator is fabricator approved by the Building Official.
4. Test reports:
   a. Certified copies of mill tests.
   b. Manufacturer's load test and temperature sensitivity data for post-installed anchor bolts.
   c. Test reports for all structural steel work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle and store steel members above ground on skids or other supports.

1. Keep free of dirt and other foreign material and protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. High-strength bolts:
   a. Portland Bolt and Manufacturing Company.
   b. Lewis Bolt & Nut Company.
   c. Nucor Fasteners.
   d. St. Louis Screw and Bolt Company.
2. Load indicator washers for high-strength bolts:
   a. Portland Bolt and Manufacturing Company.
   b. Mid-South Bolt and Screw Co., Inc.
   c. J and M Turner, Inc.
3. Alternate design high-strength bolts:
   a. T. C. Bolt Corporation.
   b. Construction Fastener Systems Division of Bristol Machine Company.
   c. LeJuene Bolt Co.
4. Headed studs and deformed bar anchors:
   a. Nelson Stud Welding Division, TRW, Inc.
   b. Stud Welding Products, Inc.
5. Mechanical anchor bolts:
   a. See Section 03 15 19.
6. Adhesive anchors bolts:
   a. See Section 03 15 19.
7. Anchor bolt sleeves:
   a. Sinco/Wilson.

2.2 MATERIALS

A. Steel, Structural Shapes and Plate (unless noted otherwise on Drawings):

1. All W-shapes and WT-shapes: ASTM A992/A992M.
2. All other plates, bars and rolled shapes: ASTM A36/A36M.

B. Pipe: ASTM A53/A53M, Grade B (Type E or S) (Fy=35).

C. Hollow Structural Sections (HSS):

1. Round: ASTM A500/A500M, Grade B (Fy=42).
2. Square or rectangular: ASTM A500/A500M, Grade B (Fy=46).

D. High-Strength Bolts, Nuts and Washers:

1. ASTM F3125, Grade A325 with ASTM A563 nuts galvanized:
2. High-strength bolts:
   a. Provide two ASTM F436 washers for all bolts galvanized.
   b. Provide beveled washers at connections of sloped/tapered sections.
3. High-strength bolts with compressible washer type direct tension indicators (DTI), ASTM F959.
   a. Provide at Contractor's option and subject to approval of Engineer.
4. Alternate high-strength design: Provide at Contractor's option and subject to approval of Engineer.

E. Bolts, Non-high Strength: ASTM A307, Grade A.

F. Threaded Rod: ASTM F1554, Grade 36.

G. Washers, Plain (for Non-high Strength Bolts): ASME B18.22.1, Type B.

H. Welding Electrodes:

1. Shielded metal arc: AWS A5.1/A5.1M or AWS A5.5/A5.5M, E70XX or E801X-X.
2. Submerged arc: AWS A5.17/A5.17M or AWS A5.23/A5.23M, F7XX-EXXX or F8XX-EXXX-XX.
3. Gas metal arc: AWS A5.18/A5.18M, E70S-X or E70U-1 or AWS A5.28/A5.28M, ER80S-XX, E80C-XXX.
4. Flux cored arc: AWS A5.20/A5.20M, E7XT-X (except 2, 3, 10, GS), AWS A5.29/A5.29M, E7XT-X or E8XTX-X, E8XTX-XM.

I. Anchor Rods and Bolts:

1. See Section 03 15 19.

J. Headed Studs and Deformed Bar Anchors:

1. Headed studs:
   a. ASTM A108, complying with AWS D1.1/D1.1M, Section 7, Type B; minimum yield strength 50,000 psi, minimum tensile strength 60,000 psi.
   b. Uniform diameter.
   c. Heads: Concentric and normal to shaft.
   d. Weld end: Chamfered and solid flux.
2. Deformed bar anchor:
   a. ASTM A1064/A1064M, complying with AWS D1.1/D1.1M, Section 7, Type C.
   b. Minimum yield strength: 70,000 psi.
   c. Minimum tensile strength: 80,000 psi.
   d. Straight, unless indicated otherwise.
   e. Solid flux.
3. After welding, remove ceramic ferrules and maintain free from any substance which would interfere with function, or prevent bonding to concrete.

K. Nonshrink Grout: See Specification Section 03 31 31.

L. Mechanical and Adhesive Anchor Bolts for Fastening to Concrete:

1. See Specification Section 03 15 19.

2.3 FABRICATION

A. Comply with requirements of applicable building code and AISC 360 with modifications and additional requirements specified herein.

1. Identify high-strength steel material in fabricated members in accordance with ASTM A6/A6M.

B. Minimize the amount of field welding.

1. Shop assemble components into largest size possible commensurate with transportation and handling limitations.
2. Shop connections: Bolted with high-strength bolts or welded.

C. Connection Details:

1. Provide as a minimum, two, 3/4 inches diameter, high-strength bolts for all bolted connections unless otherwise specified.

D. Provide bearing type connections for all bolted connections, unless otherwise noted.

E. Field Connections:

1. Provide bolts for all field connections except where shown otherwise on the Drawings.
2. Use high-strength bolts unless shown or specified otherwise.
3. Use of high-strength bolts: Conform to RCSC Specification for Structural Joints Using High-Strength Bolts.
4. Unfinished bolts may be used for attaching stair treads to stringers.
5. If structural steel details (field welds versus shop welds, etc.) shown on design Drawings are not compatible with selected erection procedures, submit proposed modifications for review.
6. Connections to structural steel provided by others: Provide all connectors and coordinate location of bolt holes to match connection holes in steel provided by others.

F. Accurately mill column end bearing surfaces to true plane.

G. Fabricate and erect beams with non-specified camber in accordance with AISC 360, Chapter L1.

H. Cut, drill, or punch holes at right angles to surface of metal.

1. Do not make or enlarge holes by burning.
2. Make holes clean cut, without torn or ragged edges.
3. Remove outside burrs resulting from drilling or reaming operations with tool making 1/16 IN bevel.
4. Provide holes in members to permit connection of work of other trades or contractors.

I. Make allowance for draw in all cross bracing to provide small amount of initial tension in members.

J. Make splices only where indicated or where approved.

K. Wall Girts:

1. Extend past columns and miter ends unless noted otherwise.
2. Connect girts to each other at corners unless noted otherwise.

L. Cope at 45 degrees, corners of stiffener plates at junction of member flanges with webs.

M. Flame cut bevels for welds, provided such cutting is done automatically.

1. Leave free of burrs and slag by grinding or planing the cut edges.

N. Grind smooth all rough welds and sharp steel edges shall be ground to approximately 1/8 inches radius.

O. Tolerances (unless noted otherwise on Drawings):

1. When material received from the mill does not satisfy ASTM A6/A6M tolerances for camber, profile, flatness or sweep, Contractor is permitted to perform corrective work by the use of controlled heating, and mechanical straightening, subject to the limitations of the AISC 360.
2. Fabrication tolerance:
   a. Member length:
      1) Both ends finished for contact bearing: 1/32 inches.
      2) Framing members: 30 feet or less: 1/16 inches, Over 30 feet: 1/8 inches.
   b. Member straightness:
      1) Compression members: 1/1000 of axial length between points laterally supported.
      2) Non-compression members: ASTM A6/A6M tolerance for wide flange shapes.
   c. Specified member camber (except compression members):
      1) 50 feet or less: -0/+1/2 inches.
      2) Over 50 feet: -0/+1/2 inches (+1/8 inches per 10 feet over 50 feet).

3) Members received from mill with 75% of specified camber require no further cambering.
4) Fabricate beams/trusses without specified camber so after erection, camber is upward.
5) Measure camber in fabrication shop in unstressed condition.

d. Use filler plates at bolted splices to take up depth deviation.
1) At welded joints, adjust weld profile to conform to variation in depth.
2) Slope weld surface per AWS requirements.

e. Free finished members from twists, bends and open joints.
1) Sharp kinks, bends and deviation from the above tolerances are cause for rejection of material.

2.4 WELDING

A. Comply with AWS D1.1/D1.1M, and other requirements indicated herein, for all welding, techniques of welding employed, appearance and quality of welds, and methods used to correct defective work.
1. Qualify joint welding procedures or test in accordance with AWS qualification procedures.

B. Test and qualify welders, welding operators and tackers in compliance with AWS D1.1/D1.1M for position and type of welding to which they will be assigned.
1. Conduct tests in presence of approved testing agency.
2. Certification within previous 12 months will be acceptable, provided samples of the welder's work are satisfactory.

C. Before Starting Welding:
1. Carefully plumb and align members in compliance with specified requirements.
2. Fully tighten all bolts.
3. Comply with AWS D1.1/D1.1M, Section 5 for assembly and surface preparation.
4. Preheat base metal to temperature stated in AWS D1.1/D1.1M.
a. When no preheat temperature is given in AWS D1.1/D1.1M and base metal is below 50 degrees F, preheat base metal to at least 70 degrees F.
b. Maintain temperature during welding.
c. Preheat surface of all base metal within distance from point of welding equal to thickness of thicker part being welded or 3 inches, whichever is greater, to specified preheat temperature.
d. Maintain this temperature during welding.
5. Mark welds with an identifying mark unique to each welder.

D. Make flange welds before making web welds.

E. Where groove welds have back-up plates, make first three passes with 1/8 inches round electrodes.
1. Use backup plates in accordance with AWS D1.1/D1.1M, extending minimum of 1 inch either side of joint.

F. Flame cut edges of stiffener plates at shop or field butt weld.
1. Do not shear.

G. Grind flush web fillets at webs notched to receive backup plates for flange groove welds.

H. Low Hydrogen Electrodes: Dry and store electrodes in compliance with AWS D1.1/D1.1M.

I. Do not perform welding when ambient temperature is lower than 0 degrees F or where surfaces are wet or exposed to rain, snow, or high wind, or when welders are exposed to inclement conditions.

J. Headed Studs and Deformed Bar Anchors:

1. Automatically end welded in accordance with the AWS D1.1/D1.1M and manufacturer's recommendations.
2. Fillet welding of headed studs and deformed bar anchors is not allowed unless approved by Engineer.

K. Test in-place studs in accordance with requirements of AWS D1.1/D1.1M to ensure satisfactory welding of studs to members.

1. Replace studs failing this test.

L. When headed stud-type shear connectors are to be applied, clean top surface of members to receive studs in shop to remove oil, scale, rust, dirt, and other materials injurious to satisfactory welding.

1. Do not shop paint or galvanize metal surfaces to receive field applied studs.

2.5 SHOP COATING

A. Refer to Specification Section 09 96 00 and coordinate shop primer, surface preparation and coating with field applied primers and coatings where specified.

B. Provide suitable methods of handling and transporting painted steel to avoid damage to coating.

C. Do not coat following surfaces:

1. Machined surfaces, surfaces adjacent to field welds, and surfaces fully embedded in concrete.
2. All other members for which no coating is specified.
3. Contact surfaces at bolted slip-critical connections, unless surface condition conforms to the RCSC Specification for Structural Joints Using High-Strength Bolts, Part 3.2.2.

D. Clean thoroughly all surfaces not coated before shipping.

1. Remove loose mill scale, rust, dirt, oil and grease.
2. Protect machined surfaces.

2.6 SOURCE QUALITY CONTROL

A. Special Inspection and Testing:

1. See Specification Section 01 45 33.
2. If the fabricator is not an Approved Fabricator, Owner will employ the services of an independent testing agency to inspect and test structural steel shop work for compliance with Specifications.
   a. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
3. Contractor responsible for testing to qualify shop welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.

B. Approved Fabricator or Testing Agency Responsibilities:

1. Inspect shop and field welding in accordance with AWS D1.1/D1.1M, Section 6 including the following non-destructive testing:
   a. Visually inspect all welds.
   b. In addition to visual inspection, test 50% of full penetration welds and 20% of fillet welds with liquid dye penetrant.
   c. Test 20% of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
   a. Verify proper pretension for slip-critical bolted connection only.

b. Verify direct tension indicator gaps for slip-critical bolted connection only.

3. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.
4. Prepare and submit inspection and test reports to Engineer.

2.7 GENERAL

A. Contractor is solely responsible for safety.

1. Construction means and methods and sequencing of work is the prerogative of the Contractor.
2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, bracing or rigid connections are installed.
3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
4. Until all elements of the permanent structure and lateral bracing system are complete, provide temporary bracing designed, furnished, and installed by the Contractor for the partially complete structure.

B. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including wind, construction activities, and operation of equipment, is the responsibility of the Contractor.

1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
3. Design of the temporary bracing system and consideration of the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades, is the Contractor's responsibility.
   a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
4. Remove and dispose of all temporary work and facilities off-site.

C. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.

1. Report defects in work-in-place which may influence satisfactory completion of the work.
2. Absence of such notification will be construed as acceptance of work-in-place.

D. Field Measurement:

1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
2. Contractor is responsible for the accurate fit of the work.

E. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.

1. Notify Engineer of any errors or deviations found by such checking.

PART 3 - EXECUTION

3.1 ERECTION

A. Framing member location tolerances after erection shall not exceed the framing tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

B. Erect plumb and level; introduce temporary bracing required to support erection loads.

C. Use light drifting necessary to draw holes together.

1. Drifting to match unfair holes is not allowed.

D. Welding:

1. Conform to AWS D1.1/D1.1M and requirements of this Specification Section.
2. Join two (2) sections of steel of different ASTM designations using welding techniques in accordance with a qualified AWS D1.1/D1.1M procedure.

E. Shore existing members when unbolting of common connections is required.

1. Use new bolts for rebolting connections.

F. Clean stored material of all foreign matter accumulated during erection period.

G. Clean bearing and contact surfaces before assembly.

H. Set beam and column base and bearing plates accurately, as indicated, on nonshrink grout.

1. Set and anchor each base plate to proper line and elevation.
2. Use metal wedges, shims or setting nuts as required and tighten anchor bolts.
   a. Use same metal as base plate.
   b. Cut off protrusions of wedges and shims flush with edge of base plate.
3. Fill sleeves around anchor bolts with nonshrink grout.
4. Pack grout solidly between bottom of plate and bearing surface.
5. Refer to Specification Section 03 31 31for nonshrink grout requirements.

I. Cast-in-place Anchor Bolts:

1. See Specification Section 03 15 19.

J. Install high strength bolts with hardened washers.

1. Install and tighten in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.
2. Coordinate installation with inspection.
   a. Do not start installation until coordination with Testing Agency is complete.
3. Bearing-type connections: High-strength bolts shall be tightened to snug-tight condition.
4. Slip-critical connections:
   a. Perform calibration testing for all methods of installation of high-strength bolts in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts, Section 8.2.
   b. Turn-of-nut tightening:
      1) Inspector shall observe the pre-installation verification testing.
      2) Subsequently, ensure by routine observation that the bolting crew properly rotates the turned element relative to the unturned element by the amount specified.
      3) Alternatively, when fastener assemblies are match-marked after the initial fitup of the joint but prior to pretensioning, visual inspection after pretensioning is permitted in lieu of routine observation.
   c. Calibrated wrench tightening: Calibrate on a daily basis.
   d. Direct tension indicator tightening: If previously approved by Engineer.
   e. Installation of alternate design bolts: If previously approved by Engineer.
5. In the event any bolt in a connection is found to be defective, check and retighten all bolts in the connection.

K. Do not use gas cutting to correct fabrication errors.

1. In case members do not fit or holes do not match, ream out the holes and insert the next larger size bolt.
    a. Drill new holes if the connections require new holes.
    b. Make no such corrections without prior approval of the Engineer.
2. Burning of holes is not permitted.

L. Prior to making field connections to existing structural steel, remove completely all paint from existing steel which will be in contact with new steel and new welds.

M. Tighten and leave in place erection bolts used in welded construction.

N. Provide beveled washers to give full bearing to bolt head or nut where bolts are to be used on surfaces having slopes greater than 1 in 20 with a plane normal to bolt axis.

O. After bolts are tightened, upset threads of non-high strength bolts and anchor bolts to prevent nuts from backing off.

P. After Erection:
1. Grind smooth all sharp surface irregularities resulting from field cutting or welding.
2. Power tool clean welds, bolts, washers and abrasions to shop coat removing all rust and foreign matter.

Q. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
1. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

A. Special Inspection and Testing:
1. See Specification Section 01 45 33.
2. Special Inspection to be in accordance with the building code.
3. Special Inspection is required for:
    a. Material verification of high-strength bolts, nuts, and washers.
        1) Frequency: All high-strength bolts, prior to being covered up or substantial completion.
    b. Inspection of high-strength boltings:
        1) Frequency:
            a) All high-strength bolts, prior to being covered up or substantial completion.
            b) Pretensioned and slip-critical joints using turn-of-nut without match marking or calibrated wrench methods of installation require continuous inspection.
    c. Material verification of structural steel.
        1) Frequency: Prior to being covered up or substantial completion,
    d. Material verification of weld filler materials.
        1) Frequency:
            a) Prior to welding on site.
            b) Randomly thereafter.
    e. Inspection of welding.
        1) Frequency:
            a) Visually inspect all welds.
            b) In addition to visual inspection, test 50% of full penetration welds and 20% of fillet welds with liquid dye penetrant or magnetic particle.
            c) Test 20% of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
    f. Inspect structural steel which has been erected.
        1) Frequency: Prior to members being covered up or substantial completion.

g. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.

4. Special Inspection to be in accordance with the building code and AISC 360.
   a. Special Inspector to perform all quality assurance inspections required by AISC 360, Chapter N.
5. Special Inspection is required for:
   a. Inspection of welds before, during and after welding.
   b. Nondestructive Testing of Welded Joints.
   c. Inspection of High Strength Bolts before, during and after bolting.
   d. Other inspection tasks:
      1) Anchor rods and embedded items.
      2) Inspect structural steel which has been erected.
   e. Inspect stud welding in accordance with AWS D1.1/D1.1M, Section 7.8.

B. Erected Framing Tolerance, unless noted otherwise on the Drawings:
1. Do not exceed cumulative effect of rolling, fabrication and erection tolerance for overall finished dimensions.
2. Erection tolerances are defined relative to member working points and working lines as follows:
   a. Actual centerline of top flange or surface at each end for horizontal members.
   b. Actual center of member at each end for all other members.
   c. Other points may be used, providing they are based on these definitions.
   d. Working line is straight line connecting member working points.
3. Tolerances on position and alignment are as specified in the Code, unless otherwise modified.
   a. Provide "adjustable items" such as lintels, wall supports, curb angles, window mullions and similar members with adjustable connections to supporting structural framing.
4. Certification by steel erector:
   a. Certify the location of erected structural steel is acceptable for plumbness, level and aligned within tolerances specified.
   b. Provide certification upon completion of any part of work.
   c. Provide certification prior to start of work by other trades that may be supported; attach to structural steel work.

3.3 CLEANING AND REPAIR OF SHOP PRIMER PAINT

A. After erection, clean all steel of mud or other foreign materials, and repair any damage.
1. Touchup coatings to comply with Specification Section 09 96 00.

END OF SECTION

SECTION 05 30 00
METAL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manufactured roof decking.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 01 45 33 - Code-Required Special Inspections and Procedures.
2. Section 09 96 00 - High Performance Industrial Coatings.

1.2 REFERENCES

A. Reference Standards:

1. American Iron and Steel Institute (AISI):
   a. S100, Specification for the Design of Cold-Formed Steel Structural Members.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   c. A780/A780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   d. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
   e. C1513, Standard Specification for Steel Tapping Screws for Cold Formed Steel Framing Connections.
   f. D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   g. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
3. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.3/D1.3M, Structural Welding Code - Sheet Steel.
4. Steel Deck Institute (SDI):
   a. 31, Design Manual for Composite Decks, Form Decks and Roof Decks.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Decking Manufacturer:
   a. Manufacturer shall possess current, valid, full membership in SDI; associate membership is unacceptable. Submit to Engineer documentation of such membership.
2. Welders:
   a. Qualify welding processes, operations, and personnel in accordance with AWS D1.1 and AWS D1.3, for decking manufacturing and welding at the Site.
   b. Welders shall be qualified, as indicated in the paragraph immediately above, during the 12-month period preceding commencement of welding for the Work and be experienced in welding light-gage metal.

c. Promptly submit documentation of qualifications when requested by Engineer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Complete framing and erection plans and details.
   b. Location, length, type, cross section, thickness, and markings of metal decking units.
   c. Size and location of each opening in decking and conditions requiring closure panels and supplementary framing. Show and indicate necessary accessories and reinforcing.
   d. Sequence and procedure to be followed for erecting, fastening, and securing decking. Engineer's approval or commenting on Shop Drawings does not in any way reduce or mitigate Contractor's responsibility for means, methods, procedures, techniques, and sequences of construction or for safety and protection measures incident thereto.
   e. Show and indicate units and surfaces to receive shop-applied finishing, as applicable.
   f. Location of required shoring for decking. Engineer's approval or comments on Shop Drawings showing or indicating such information in no way reduces or modifies Contractor's obligations for construction means, methods, sequences, procedures, and techniques and safety and protection measures incident thereto.
   g. Details and gages of accessories and miscellaneous items, showing sump pans, cant strips, ridge and valley plates, closure and filler strips and insulation supports.
   h. Fasteners and welding details for installation, including size, spacing, type, and location of fasteners necessary and required to secure decking.
   i. Recommended welding rod size, type, burn-off rate, and welder setting for deck thickness to be joined. Engineer's approval or comments on Shop Drawings showing or indicating such information in no way reduces or modifies Contractor's obligations for construction means, methods, sequences, procedures, and techniques and safety and protection measures incident thereto.
   j. Define welds by indicating standard AWS welding symbols.
   k. Shop Drawings shall not be developed from or reproductions of the Drawings prepared by Engineer.
2. Product Data:
   a. Manufacturer's specifications and published catalog data for:
      1) Welds and welding procedure.
      2) Galvanizing repair paint.
      3) Screws.
      4) Powder actuated fasteners.
      5) Joint sealing compound.
   b. Manufacturer's load tables for decking to be provided, including:
      1) Allowable gravity load for metal roof decking.
      2) Allowable diaphragm shear values for metal roof deck.
      3) Allowable metal decking superimposed load.
      4) Allowable unshored span lengths for decking.

B. Informational Submittals: Submit the following:

1. Certifications:
   a. Manufacturer's certification that metal decking provided complies with specified requirements, including:
      1) Deck material, manufacturing, and shop testing and inspection are in accordance with SDI requirements.
2. Supplier's Instructions:

a. Manufacturer's written instructions for storing, handling, and installing materials furnished.

3. Test and Evaluation Reports:
   a. Powder driven fastener ICC-ES Evaluation Report(s).
4. Source Quality Control Submittals:
   a. Manufacturer's certified test and mill reports for actual materials furnished.
5. Qualifications Statements:
   a. Evidence of manufacturer's current, valid SDI membership.
   b. Welder qualifications and certifications, when requested by Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Handling:
   1. Comply with the Contract Documents, SDI requirements and recommendations, and decking manufacturer's written instructions.

B. Storage:
   1. Comply with the Contract Documents, SDI requirements and recommendations, and decking manufacturer's written instructions.
   2. Store metal decking off the ground, entirely covered by waterproof covering, with one end elevated for drainage. Properly vent waterproof covering to avoid condensation.
   3. Prevent corrosion, deterioration, and accumulation of foreign matter.
   4. Prevent formation of "white rust" on surfaces with galvanized finish.
   5. Do not overload supporting members.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. 3-inch deep metal roof decking:
      a. Vulcraft.
      b. Verco Decking.
      c. New Millennium Building Systems.
      d. DACS.

2.2 METAL ROOF DECKING

A. Design of the metal decking shall be checked by decking manufacturer's professional engineer and found by such professional engineer to comply with SDI's standard specifications and load tables.
   1. Allowable superimposed live uniform loading per square foot for metal roof decking provided for spans shown or indicated shall equal or exceed allowable superimposed live uniform load per square foot for same spans as indicated in SDI's tables.
   2. Maximum Deflection: Less than 1/240 of span under live load.

B. Provide decking configurations complying with SDI 31 and as shown and indicated.
   1. Galvanized Decking: ASTM A653 G60 zinc coating.

C. Metal Roof Decking, 3-Inch Deep:
   1. Rib type N, sheet steel, 18-gage, minimum, , galvanized.

2.3 FABRICATION

A. Standard Deck Profiles:

DEPTH	TYPE (Vulcraft designations, UNO)	RIB SPACING	TOP SURFACE MAXIMUM RIB OPENING	MINIMUM BOTTOM OF RIB WIDTH
1-1/2 inches	Roof Deck Intermediate Rib ('1.5F')*	6 inches	1-3/4 inches	1/2 inches
3 inches	Roof Deck ('3NI')	8 inches	4-3/8 inches	2-1/16 inches

* Indicates produced by DACS

B. Minimum Deck Thickness:

1. Where gage of metal is indicated, provide the not less than uncoated thickness required by SDI.
   a. Delivered thickness of uncoated steel: Not less than 95 percent of the stated thickness.
2. Use steel with minimum yield stress of 33 ksi.
3. Comply with deflection limits, especially when proposing steel with greater strength than required in this provision.

C. Fabrication:

1. Fabricate decking units in lengths to span three or more support spacings with flush, telescoped or nested end laps not less than 2 inches.
   a. End laps shall occur on supporting members.
   b. Provide decking units with overlapping male and female type side laps or joints to provide positive vertical and lateral alignment of adjacent decking units.

2.4 ACCESSORIES

A. Metal Closures:

1. Form to configuration required for tight-fitting closures at open ends and sides of decking.
2. Minimum thickness before galvanizing: 0.0358-inch (20-gage).

B. Welding Washers:

1. 16-gage bent steel plate with 3/8-inch or as required by weld size center hole.
2. Provide at all deck units thinner than 22-gage.

C. Filler Sheet:

1. Flat or formed 20-gage galvanized steel.

D. Roof Sump Pans:

1. Provide roof sump pans at locations shown.
2. Fabricate each from single piece of galvanized sheet steel with level bottom and sloping sides to direct water flow to drain.
3. Provide sump pans of adequate size to receive roof drains with bearing flanges not less than three inches wide.

4. Recess pans not less than 1.5 inches below roof deck surface, unless otherwise shown or indicated or required by deck configuration.
5. Minimum thickness before galvanizing: 0.0747-inch (14-gage).

E. Cant Strips:

1. Provide bend cant strips to form 45-degree slope not less than five inches wide, with top and bottom flanges not less than three inches wide.
2. Minimum thickness before galvanizing: 0.0358-inch (20-gage).

F. Insulation Supports:

1. Provide insulation supports that do not impair quality or finish of decking.

G. Venting:

1. Provide slotted openings in bottom flutes in accordance with manufacturer's standards.

H. Primer Paint:

1. Unless otherwise required in the Contract Documents, provide decking manufacturer’s baked-on, rust-inhibitive paint, factory-applied to chemically cleaned and phosphate treated metal surfaces.
2. Paint is not required for galvanized surfaces, unless otherwise indicated.

I. Galvanized coating for metal decking accessories: Comply with ASTM A653 (or equivalent) G60 zinc coating.

J. Galvanizing Repair Materials:

1. Galvanized repair paint shall be in accordance with Section 09 96 00 - High Performance Industrial Coatings.

K. Screws:

1. Self-drilling, self-tapping, no. 12 size minimum, hex washer head metal screws.
2. Protected carbon steel, Hilti S-MD KF, or equal.
   a. Kwik-Cote finish.
   b. ASTM C1513 or equal.

L. Powder Actuated Mechanical Fasteners:

1. Material: AISI 1070 modified.
2. Hardness: Minimum Rockwell Hardness C 54.5.
3. Strength: Minimum tensile strength 285 ksi; minimum shear strength 175 ksi.
4. Design and Manufacture: Knurled shank with forged ballistic point. Manufacturing process shall ensure steel ductility and prevent development of hydrogen embrittlement.
5. Washers:
   a. For Steel bar Joist Framing: Minimum 12 mm (0.472-inch) steel washers.
   b. For Structural Steel Framing: Minimum 15 mm (0.591inch) steel washers.
6. Corrosion Resistance:
   a. For steel roof decks with waterproofing membrane: Five-micron zinc electroplated in accordance with ASTM B633 SC1 Type III.
   b. For exposed steel roof decks: Minimum AISI 304 stainless steel sealing caps with bonded neoprene washer shall be provided over each fastener.
7. Design Requirements:
   a. ICC-ES AC43 or SDI method for diaphragm shear strength and stiffness.
   b. FM wind uplift resistance.
   c. UL fire classification.

8. Products and Manufacturers:
    a. For use with steel bar joist and light structural steel framing supports with top chord or flange thickness 1/8-inch to 3/8-inch:
        1) Hilti X-HSN24 (1/8-inch up to and including 3/8-inch).
        2) Or equal.
    b. For use with structural steel framing supports with top flange thickness 1/4-inch or thicker:
        1) Hilti X-ENP-19 L15 (1/4-inch or thicker).
        2) Or equal.

M. Miscellaneous Steel Shapes:
    1. Comply with ASTM A36.

N. Sheet Metal Accessories:
    1. Provide of same material and finish as decking panels.

2.5 SOURCE QUALITY CONTROL

A. Tests and Inspections:
    1. Before shipping materials from the shop or fabrication facility to the Site or offsite storage, perform manufacturer's or fabricator's ordinary inspections, testing, and other source quality control activities.
    2. Do not ship materials that are damaged or otherwise defective.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examination:
    1. Examine areas and conditions under which metal decking will be installed for conditions detrimental to proper and timely completion of the Work.
    2. Do not proceed with the Work until unsatisfactory conditions are remedied.

B. Do not start installing metal decking until supporting Work is in place and properly secured.

3.2 INSTALLATION

A. Installation – General:
    1. Install decking in accordance with the Contract Documents, SDI requirements and recommendations, decking manufacturer's written instructions and approved Submittals. In event of conflict among such requirements, obtain Engineer's written interpretation or clarification before proceeding with the associated Work.
    2. Loading During Handling and Installation:
        a. Do not overload supporting structural members or architectural elements.
        b. Until entire assembly is substantially complete, structural elements may be unstable or incapable of supporting loads required by code or design loads indicated in the Contract Documents.
        c. Locate deck bundles to prevent overloading of structure.
        d. Ensure decking construction loads are less than recommendation of SDI 31, except where adequate temporary supports are provided.
    3. Provide decking manufacturer's standard accessories as needed to complete decking Work installation.
    4. Install each decking unit on supporting structural frame, adjust to final position and accurately align with ends properly bearing on supporting members.
    5. Interlock decking units at sides without stretching, contracting, or deforming.

6. Install deck units flat and square and secure to framing without warp or excessive deflection.
7. Install decking units in accurate and close alignment for entire length of run and with close alignment of flutes of one unit with those of abutting unit.
8. Refer to requirements, below in this Article, applicable to all decking, including:
    a. Cutting, fitting, and openings.
    b. Temporary supports.
    c. Welding – general.
    d. Fastening (mechanical and welding).
    e. Accessories.

B. Roof Decking:
1. Install roof decking units and accessories as required, in accordance with SDI 31.
2. Lap roof deck units at ends not less than 2 inches.
3. Refer to requirements, below in this Article, for roof decking provisions on:
    a. Insulation supports.
    b. End closures.
    c. Roof sump pans.
    d. Cant strips.
    e. Others.

C. Cutting, Fitting, and Openings:
1. Cut and fit deck units and accessories around other construction projecting through or adjacent to decking.
2. Comply with Section 01 73 29 - Cutting and Patching.
3. Make cutting and fitting neat, square, and trim.
4. Cut decking by mechanical means, not by burning.
5. Neatly and accurately install reinforcing at openings, except:
    a. Circular openings less than six-inch diameter.
    b. Rectangular openings having no side dimension greater than 6 inches.
6. Reinforcing at Openings:
    a. Reinforce openings that are not framed between 6 inches and 1 foot with 20-gage flat steel sheet, 1-foot greater in each dimension than opening.
    b. Provide sheeting around opening. Fusion-weld to top surface of deck at each corner and midway along each side.

D. Field Welding – General:
1. Plug weld sizes indicated are effective fusion diameter of welds.
2. Weld metal shall penetrate all layers of deck material and have good fusion to supporting members.
3. Do not burn through deck.

E. Fastening (Mechanical and Welded):
1. Prevent over-torqueing of screw fasteners by using a tool with depth-limiting nosepiece and clutch.
2. Fastening of Three-inch Deep Metal Roof Deck:
    a. Unless otherwise shown or indicated, secure decking units to supporting frame and side laps as follows:
        1) Fasten edge ribs of panels at each support.

2) At interior supports and at ends of deck provide:
   a) Four, 5/8-inch round plug welds per decking unit (2-foot unit).
   b) Install 20-gage and thinner deck with welding washers at specified weld locations.
3) At perimeter supports 5/8-inch round plug welds at 1-foot on centers.
4) At side laps, provide no. 12 hex-head screws at 1.5 feet on centers.

F. Insulation Supports:
   1. Provide insulation supports as necessary and required.
   2. Provide insulation supports where top surface of roof decking does not extend as necessary and required to completely support roof insulation.
   3. Weld insulation supports into position.

G. Closure Strips:
   1. Provide metal closure Strips at open, uncovered ends and edges of roof decking, and in voids between deck and other construction.
   2. Weld closure strips into position to provide complete decking.

H. Roof Sump Pans:
   1. Provide over openings in roof decking.
   2. Weld to top deck surface. Space welds at not more than 1-foot on center with not less than one weld at each corner and each side midway between each corner.
   3. Cut opening in bottom of roof sump to accommodate drain size shown or indicated.

I. Cant Strips:
   1. Provide cant strips welded to top surface of roof decking at 1-foot on centers.
   2. Lap end joints not less than 3 inches.

J. Accessors:
   1. Provide metal accessories to close all openings and gaps between decking and other construction, at objects projecting through decking, at locations where decking changes direction, and at open ends of deck units where deck units terminate.
   2. Weld into position to provide a complete installation.

K. Cleaning and Touch-Up:
   1. After installation, remove surplus materials and debris from decking surfaces. Comply with Section 01 74 00 - Cleaning.
   2. Field-repair shop-painted surface in accordance with paint or coating manufacturer's written instructions and applicable provisions of the Contract Documents.
   3. Repair damaged galvanized surfaces in accordance with Section 05 50 00 - Metal Fabrications.

3.3 FIELD QUALITY CONTROL

A. Code-Required Special Inspection:
   1. Comply with Section 01 45 33 - Code-Required Special Inspections and Procedures.
   2. Special inspection is required for:
      a. Verifying proper decking materials and layout.
         1) Frequency: Prior to attaching decking to structure.
      b. Verifying proper weld filler materials, screws, powder actuated mechanical fasteners, weld testing and fastener spacing.
         1) Frequency:
            a) First four hours during the first day of decking attachment; and

b) Inspection prior to covering decking Work with concrete, insulation, or other materials.

B. Defective Work:

1. Metal decking Work will be deemed defective Work and will be rejected by Engineer when it:
   a. Does not comply with SDI requirements and recommendations.
   b. Does not comply with the Contract Documents.
   c. Is improperly: manufactured, finished, and installed.
   d. Is damaged resulting in impaired strength, defacing, or inappropriate appearance.
2. Remedy defective Work in accordance with the Contract Documents. Replace damaged decking with new decking in accordance with the Contract Documents
3. Remove and replace decking that:
   a. Is structurally weak or unsound.
   b. Has burn holes due to improper welding; or
   c. Is deemed defective Work by Engineer (unless Engineer expressly allows repair or other remedy).

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
   a. Bollards
   b. Abrasive Stair Nosings
   c. Aluminum Grating
   d. Steel Grating
   e. Heavy-Duty Castings, Trench Covers, and Accessories
   f. Access Cover
   g. Loose Lintels
2. Design of all temporary bracing not indicated on Drawings.
3. Delegated design systems and components, including but not limited to:
   a. Metal Stairs.
   b. Concrete Filled Steel Pan Stairs.
   c. Landings.
   d. Ladders.
   e. Landing and Ladder gates.
   f. Steel checkered plate.
   g. Fall protection rail system.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 35 73 – Delegated Design Procedures.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 03 31 30 - Concrete, Materials and Proportioning.
4. Section 05 12 00 - Structural Steel.
5. Section 05 52 23 - Steel Railings.
6. Section 05 52 43 – Welded Aluminum Railings.
7. Section 06 82 00 - Fiberglass Reinforced Plastic Fabrication.
8. Section 07 61 13 – Metal Roofing
9. Section 09 96 00 - High Performance Industrial Coatings.

1.2 REFERENCES

A. Definitions

1. Fasteners: As defined in ASTM F1789.
2. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.
3. Hardware: As defined in ASTM A153/A153M.
4. Installer or Applicator:
   a. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   b. Installer and applicator are synonymous.

5. PQR: Procedure Qualification Record
6. MIC: Microbiologically induced corrosion.

B. Referenced Standards: Standards referenced in this section include, but are not necessarily limited to, the following:

1. Aluminum Association (AA):
   a. ADM 1, Aluminum Design Manual.
2. American Association of State Highway and Transportation Officials (AASHTO):
   a. HB, Standard Specifications for Highway Bridges.
3. American Institute of Steel Construction (AISC):
   a. 325, Manual of Steel Construction.
   b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
4. The American Ladder Institute (ALI):
   a. A14.3, Ladders - Fixed - Safety Requirements.
5. American Society of Civil Engineers (ASCE):
   a. 7, Minimum Design Loads for Buildings and Other Structures.
6. ASTM International (ASTM):
   a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   b. A36, Standard Specification for Carbon Structural Steel.
   c. A47, Standard Specification for Ferritic Malleable Iron Castings.
   d. A48, Standard Specification for Gray Iron Castings.
   e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
   g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   i. A197, Standard Specification for Cupola Malleable Iron.
   j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   k. A276, Standard Specification for Stainless Steel Bars and Shapes.
   l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   n. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   o. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   q. A536, Standard Specification for Ductile Iron Castings.
   r. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
   s. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   t. A563, Standard Specification for Carbon and Alloy Steel Nuts.

u. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
v. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
w. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A992, Standard Specification for Steel for Structural Shapes.
z. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
aa. A1011, Standard 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.
bb. B26, Standard Specification for Aluminum-Alloy Sand Castings.
cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
a.
b. F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
c. F467, Standard Specification for Nonferrous Nuts for General Use.
d. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
e. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
f. F835, Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.
g. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
h. F1789, Standard Terminology for F16 Mechanical Fasteners.
i. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

7. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
   b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
   c. MBG 531, Metal Bar Grating Manual.
9. NACE International (NACE).
10. Nickel Development Institute (NiDI):
    a. Publication 11 007, Guidelines for the Welded Fabrication of Nickel-Containing Stainless Steels for Corrosion Resistant Services.
11. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Fabrication and/or layout drawings and details:
   1) Submit drawings for all fabrications and assemblies.
      a) Include erection drawings, plans, sections, details and connection details.
   2) Identify materials of construction, shop coatings and third party accessories.
2. Product technical data (for fabrications not delegated design) including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Provide manufacturer's standard allowable load tables for the following:
      1) Grating and checkered plate.
      2) Castings, trench covers and accessories.
      3) Modular framing systems.
3. Delegated Design Professional's "Instruments of Service" Submittals:
   a. Design drawings sealed and signed by delegated design professional, including:
      1) Design drawings deemed appropriate and necessary by delegated design professional.
      2) Show or indicate necessary details establishing the method of fastening throughout system and attachments to supporting primary structure including anchorage to concrete as required.
      3) Coordinate drawings and details with delegated design professional's calculations required in this Section.
      4) At option of Contractor or fabricator, design drawings may be combined with the Shop Drawings required in this Section, although delegated design professional's seal and signature is required on the Shop Drawings in the event of a combined Submittal.
   b. Design specifications, sealed and signed by delegated design professional.
   c. Certification of compliance in accordance with Section 01 35 73 - Delegated Design Procedures, including:
      1) List of design loads and load combinations used to design structural systems and components.
      2) List of loads transmitted to the supporting structural elements.
      3) Compliance with project performance and design criteria specified in the Contract Documents.
      4) Expressly indicate where structural element reaction forces to Engineer-designed supporting elements or existing construction differ from reaction forces indicated in the Contract Documents.

B. Informational Submittals:
1. Certifications
   a. NACE certification of surface preparation.
   b. NACE certification of paint application.
2. Supplier's Instructions:
   a. Fabricator's instructions for handling, storing, and installing structural elements furnished.
   b. Galvanizing repair paint manufacturer's installation instructions.
3. Qualifications Statements:
   a. NACE inspector qualifications.
   b. Delegated design professional.
   c. Fabricator, when requested by Engineer, including:
      1) Qualifications and experience.

2) Qualifications of welders to be employed in fabricating the structural elements for the Project.
3) Qualifications of welders to be employed during erection of the structural elements for the Project.

d. Installer, when requested by Engineer, including fabricator's approval of installer.

4. Delegated design Shop Drawings approved by delegated design professional:
   a. Detailed structural elements erection drawings, shop details, erection detail.
   b. Indicate member type, location, spacing, size, and gauge of members; method of attachment to supporting members; and necessary erection details.
   c. Show and indicate supplemental bracing, strapping, splices, bridging, accessories, and details necessary for proper installation.
   d. Structural element Placement Diagram: Diagram showing and indicating assumed location of each structural element and references the corresponding structural element design drawing.
5. Delegated design product data approved by delegated design professional:
   a. Fabricator's published product data for each type of structural element and accessory required.
   b. Expressly indicate compliance with applicable reference standards. If not addressed in fabricator's published information, submit as special certification addressing compliance with reference standards indicated in this Section.
   c. Published product data for galvanizing repair paint.
6. Delegated design calculations in accordance with Section 01 35 73 - Delegated Design Procedures:
   a. Complete set of design calculations, indicating:
      1) Basis of design, including a list of codes and standards used for design.
      2) List of design loads and load combinations.
      3) Design moments, shear forces, and axial compression/tension forces.
      4) Design of connections, including splices, if required.
      5) Bridging and bracing design, including attachments to trusses and anchorage to supporting structural elements, if required.
      6) Special requirements, if any.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Applicable construction codes including building code, are indicated in Section 01 42 00 - References.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS.
      a. All welders shall be qualified in all positions that will be utilized during welding. Welders shall utilize qualified PQR for testing.
      b.
   2. Fabricator shall have minimum of 10 years of experience in fabrication of metal items specified.
   3. Engineer for contractor-designed systems and components: Professional structural engineer licensed in the State of Idaho.
   4. NACE certified inspector shall have minimum of two years of experience performing inspections as indicated.
      a. Have a current Level III coating inspector certification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Abrasive stair nosings (embedded in concrete stairs):
   a. American Safety Tread.
   b. Balco.
2. Headed studs and deformed bar anchors:
   a. Nelson Stud Welding Div., TRW Inc.
   b. Stud Welding Products, Inc.
3. Mechanical anchor bolts:
   a. See Section 03 15 19.
4. Epoxy adhesive anchor bolts:
   a. See Section 03 15 19.
5. Concrete screw anchors:
   a. See Section 03 15 19.
6. Castings, trench covers and accessories:
   a. Neenah Foundry Co.
   b. Deeter Foundry Co.
   c. Barry Craft Construction Casting Co.
   d. McKinley Iron Works.
7. Aluminum ladders:
   a. Any manufacturer capable of meeting the requirements of this Specification Section.
8. Galvanizing repair paint:
   a. Aervoe Industries, Inc.
   b. ZRC Products.
9. Modular framing system:
   a. Unistrut Building Systems.
   b. B-Line Systems.
   c. Kindorf.
   d. Superstrut.
10. Fall protection rail system
    a. Capital Safety.
    b. 3M
    c. DBI Sala
11. Ladder safety extension post:
    a. Bilco.
12. Metal Plank Grating
    a. McNichols TRACTION TREAD, Button-Top, 13 Gauge, Galvanized Steel
13. Ladder safety system:
    a. DBI/SALA.

b. Miller Equipment.
c. North Specialty Products.

2.2 MATERIALS

A. Steel:
1. Structural:
a. W-shapes and WT-shapes: ASTM A992, Grade 50.
b. All other plates and rolled sections: ASTM A36.
2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
3. Structural tubing:
a. ASTM A500, Grade B (46 ksi minimum yield).
4. Bolts, high strength:
a. ASTM F3125, Grade A325.
5. Nuts, high strength:
a. ASTM A563.
6. Washers (hardened):
a. ASTM F436.
b. Provide two (2) washers with all bolts.
7. Bolts and nuts (unfinished):
a. ASTM A307, Grade A.
8. Welding electrodes: AWS D1.1, E70 Series.
9. Steel forgings: ASTM A668.

B. Iron:
1. Ductile iron: ASTM A536.
2. Gray cast iron: ASTM A48 (minimum 30,000 psi tensile strength).
3. Malleable iron: ASTM A47, ASTM A197.

C. Stainless Steel:
1. Stainless steel in welded applications: Low carbon 'L' type.
2. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
a. Bars, shapes: ASTM A276, Type 304.
b. Tubing and pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.
c. Strip, plate and flat bars: ASTM A666, Type 304 or 316.
d. Bolts and nuts: ASTM F593, Type 304 or 316.
3. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
a. Strip, plate and flat bar for welded connections, ASTM A666, Type 304L or 316L.
4. Welding electrodes: In accordance with AWS for metal alloy being welded.

D. Aluminum:
1. ASTM B26 for castings.
2. ASTM F468, alloy 2024 T4 for bolts.
3. ASTM F467, alloy 2024 T4 for nuts.
4. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.
5. ASTM B209, alloy 5052 for plank grates.

E. Washers: Same material and alloy as found in accompanying bolts and nuts.

F. Embedded Anchor Bolts:
1. See Specification Section 03 15 19.

G. Mechanical Anchor Bolts and Adhesive Anchor Bolts:

1. See Specification Section 03 15 19.

H. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

I. Deformed Bar Anchors: ASTM A1064 with a minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

J. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.

K. Galvanizing Repair Paint:

1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92% in dry film.
4. ZRC "ZRC Cold Galvanizing" or Aervoe " Crown Cold Galvanize Coating 93% Zine Rich."

L. Dissimilar Materials Protection: See Specification Section 09 96 00.

2.3 MANUFACTURED UNITS

A. Ladders:

1. General:
   a. Fully welded type.
      1) All welds to be full penetration welds, unless otherwise specified.
   b. All ladders of a particular material shall have consistent construction and material shapes and sizes unless noted otherwise on the Drawings.
   c. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and the building code.
   d. Ladders shall be designed to support a minimum concentrated live load of 300 pounds at any point to produce the maximum stress in the member being designed.
      1) Apply additional 300 pound loads for each section of ladder exceeding 10 feet.
   e. Maximum allowable stresses per AA ADM 1.
   f. Maximum allowable stresses per AISC Specification.
   g. Maximum lateral deflection: Side rail span/240 when lateral load of 100 pounds is applied at any location.
2. Material:
   a. Aluminum.
   b. Galvanized steel.
   c. Finish:
      1) Mill.
3. Rails:
   a. Round pipe or rectangular tubing:
      1) Round pipe:
         a) 1-1/2 inches nominal diameter.
         b) Schedule 80.
      2) Rectangular tubing:
         a) Cross-section: 3 by 2 inches maximum.
         b) Thickness: 0.125 inches minimum.
   b. Spacing:
      1) Minimum clear distance between rails to be 18 inches.

2) Step-through ladder extensions: 24 inches, clear maximum.
3) Ladders equipped with ladder safety system: 36 inches clear.

c. Provide cap at exposed top and bottom of side rails.
1) Provide weep holes as necessary to prevent the accumulation of moisture within hollow members.

d. Extend side rails of step-through ladders a minimum of 42 inches above the landing.

4. Rungs:
a. Minimum 1 inch diameter or 1 inch square solid bar.
1) Integral non-slip finish on all sides.
a) Non-slip finish: Coarse knurling or extruded serrations.
b) Shop or field-applied grit tape and cap type non-slip finishes are not acceptable.

b. Rungs shall penetrate inside wall of side rails.
1) Do not extend rungs beyond the outside face of the side rail.
2) Provide fillet weld all around rung at inside face of side rail and plug weld at outside face of side rail.

c. Rung spacing:
1) Equally spaced not less than 10 inches and not more than 14 inches as measured between the centerlines of the rungs.
a) Ladder rungs and steps in elevator shafts shall be spaced not less than 6 inches and not more than 16.5 inches as measured between the centerlines of the rungs.
2) Top rung shall be level with landing or platform.
a) Where top of ladder terminates at grating cover, floor access door, roof hatch or similar condition; locate top rung as close as practicable to, but not more than 6 inches below, adjacent walking surface.

5. Brackets:
a. Angle or bent plate brackets welded to side rails:
1) 3/8 inches by 2-1/2 inches by length required.
2) Provide punched holes for 3/4 inches bolts or anchors.
3) Minimum distance from centerline of rung to wall or any obstruction: 7 inches.
4) Maximum spacing: 4 feet OC.

b. For floor supported ladders, provide 3/8 by 2-1/2 by 4 inches rectangular bracket or 3/8 by 6 by 6 inches square plate welded to rails with punched holes for 3/4 inches bolts.
1) Provide wall brackets on floor supported units if vertical run is over 4 feet.

6. Landings:
a. Construct landing, railing and all supports of same material as the ladder.
b. Design live load for landing platform and supporting structure:
1) 100 PSF, uniform load.
2) 300 LBS concentrated load on 4 inches square area.
3) All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
4) Maximum deflection: 1/300 of span under a superimposed live load of 100 psf.

c. Grating:
1) Per this Specification Section.

d. Structural support: Channel or tubular sections with bracing, plates, angles, etc., to support guardrail and grating and to support landing from the side of the structure.
1) Weld or bolt all connections using stainless steel bolts, nuts and washers.

e. Guardrails:
    1) Match ladder side rails.
        a) Space intermediate rails equally between top rail and top of kickplate.
    2) Provide 4 inches high x 3/8 inches thick toeboard each side of landing.
7. Landing and Ladder Gates:
    a. Constructed of same material and sizes as the railing system.
    b. Hinges:
        1) Stainless steel.
        2) Heavy-duty, self-closing.
    c. Gate stop:
        1) .Construct gate stop of same material as the rail.
8. Ladder safety extension post:
    a. Telescoping tubular galvanized steel section that automatically locks into place when fully extended.
    b. Non-ferrous corrosion-resistant spring and hardware.
    c. Factory assembled with all hardware necessary for mounting to ladder.
    d. Bilco "LadderUp" safety post.
9. Deflector plate:
    a. For aluminum ladders: Minimum 0.0625 inches aluminum plate, ASTM B209.
    b. For stainless steel ladders: Minimum 0.0625 inches stainless steel plate, ASTM A666.
    c. For steel ladders: Minimum 0.0625 inches steel plate, ASTM A6.
    d. Profile as shown on Drawings.
    e. Fabricate to shapes and sizes required to meet OSHA Standards.
10. Ladder safety system:
    a. Extruded aluminum safety rail.
        1) Safety rail shall extend from within 3 feet of base of ladder to top of ladder side rails.
        2) Provide rung clamps at not more than 4 feet on center.
        3) Provide dismount extensions as appropriate for application shown on Drawings.
    b. Aluminum shuttle.
        1) Provide 2 shuttles per ladder.
    c. Full body harness with adjustable leg straps, backpad, and front dee ring.
        1) Provide 2 harnesses per ladder.
    d. Miller Equipment "Saf-T-Climb" system.
    e. Provide all components required for a complete OSHA compliant ladder safety system.

B. Bollards:
1. 8 inches diameter extra strength steel pipe, ASTM A53.
    a. Galvanized.
    b. See Specification Section 09 96 00 for painting requirements.

C. Abrasive Stair Nosings:
1. Exterior cast-in-place concrete stairs:
    a. One piece cast aluminum with wing anchors.
    b. Diamond abrasive pattern.
    c. Babcock Davis "BSTCA-C3W".
2. Interior stairs:
    a. Two component consisting of an embedded subchannel and an abrasive tread plate.

b. Subchannel: 6063-T5 extruded aluminum.
   1) Complete with concrete anchors.
c. Tread plate:
   1) 6063-T5 extruded aluminum.
   2) Solid epoxy abrasive filler.
      a) Color: Gray.
d. Balco "DXH-330".
e. Finish: Mill.

3. Length:
   a. Concrete stairs and landings:
      1) 4 inches less than overall stair width.
      2) Where tread mounted railing post occurs, hold nosing back 4 inches clear from railing centerline.
   b. Concrete filled metal pan stairs: Full length of tread.
   c. Concrete landings at metal stairs: 4 inches less than clear width between stringers.

D. Metal Stairs:

1. Treads: Checkered plate as specified.
   a. Provide integral corrugated non-slip nosing.
2. Risers:
   a. Grating treads:
      1) Solid plate welded to trailing edge of tread or landing.
      2) Minimum 3/16 inches thick by 4 inches high.
   b. Checkered plate treads: Solid checkered plate riser integral with tread.
3. Landings:
   a. Checkered plate as specified.
   b. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.
4. Design live load for landing platform and supporting structure:
   a. 100 PSF, uniform load.
   b. 300 LBS concentrated load on 4 inches square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 100 psf.
5. Design, fabricate, and install in compliance with NAAMM and applicable codes.
   a. NAAMM AMP 510:
      1) Exterior at site structures and equipment: Industrial Class.
      2) Interior or exterior at buildings: Industrial Class.
6. Handrails and guardrails: Refer to Specification Section 05 52 23.
7. Material:
   a. Steel: ASTM A36, galvanized after fabrication.

E. Steel Checkered Plate:

1. Provide galvanized checkered plate and edge supports.
2. Conform to ASTM A786.
   a. Diamond pattern: No.3 (large) or No.4 (medium).
   b. Use one pattern throughout Project.
   c. Material: 36 ksi minimum yield strength.
3. Design live load (unless noted otherwise on Drawings):

a. 100 psf, uniform load.
b. 300 pounds concentrated load on 4 inches square area.
c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
d. Maximum deflection: 1/300 of span under a superimposed live load of 50 psf.

4. Reinforce as necessary with steel angles welded to underside of checkered plate.
5. Plate sections:
   a. Maximum 3 feet wide.
   b. Minimum 1/4 inches thick.
   c. Maximum 100 pounds per section if required to be removable.
6. Provide joints at center of all openings unless shown otherwise.
   a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
7. Unless shown otherwise, frame for opening with steel checkered plate cover:
   a. Steel support angles:
      1) 3 by 2 by 1/4 inches minimum size with long leg vertical.
      2) 5/8 inches diameter adhesive anchor bolts spaced at maximum of 24 inches on-center along each side with not less than two anchor bolts per side.
   b. Steel concrete insert seats:
      1) 2 by 2 by 1/4 inches minimum size.
      2) Auto-welded studs or strap anchors, ASTM A108 at 18 inches on-center with not less than two studs or anchors per side.
   c. Drill and tap frame to receive 3/8 inches diameter fasteners at not more than 24 inches on-center with not less than two fasteners per side.
      1) Fasteners: Flat countersunk cap screws, ASTM F835.
         a) Galvanized, ASTM A153/A153M.

F. Metal Plank Grating:
1. NAAMM MBG 531.
2. Minimum depth: 1-1/2 inches.
3. Minimum width: 7 inches.
4. Minimum thickness: 13 gauge
5. Design live load:
   a. 60 psf, uniform load.
   b. 300 pounds concentrated load on 4 inches square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 60 psf.
6. Top surfaces of planks: Button Top
7. Standard mill finish.
8. Openings through grating to have approximately 4% open area.
9. Clips and bolts: Stainless steel.
10. Seat angles: Stainless steel.

G. Steel Grating:
1. NAAMM MBG 531.
2. Bearing bars:
   a. Rectangular 1-1/2 by 3/16 inches unless otherwise noted on Drawings.

b. Maximum 1-3/16 inches on-center spacing.

3. Cross bars:
   a. Welded, swagged or pressure locked to bearing bars.
   b. Maximum 4 inches on-center spacing.
4. Top edges of bars: Serrated or grooved.
5. Design Live Load:
   a. 40 psf, uniform load.
   b. 300 pounds concentrated load on 4 inches square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 40 psf.
6. Removable grating sections: Not wider than 3 feet and not more than 100 pounds.
7. Finish:
   a. Galvanized.
   b. Clips and bolts: Galvanized.
   c. Seat angles: Galvanized steel.
8. Ends and perimeter edges: Banded.
9. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 inches high toe plate.
10. Provide joints at openings between individual grating sections.

H. Access Cover:

1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
3. Equip lid with four stainless steel screws to secure lid to frame.

I. Loose Lintels:

1. Steel, ASTM A36 or ASTM A572 Grade 50, sizes as indicated on Drawings.
2. Hot-dip galvanized per ASTM A123/A123M.

J. Modular Framing System:

1. Materials:
   a. Steel: ASTM A1011, carbon steel, Grade 33.
      1) Hot-dipped galvanized, ASTM A123 or ASTM A153.
   b. Aluminum: ASTM B221 or ASTM B209.
   c. Stainless steel: ASTM A666.
   d. Fiberglass: See Specification Section 06 82 00.
2. Channels and inserts:
   a. Steel or stainless steel: Minimum 12 GA.
   b. Aluminum: Minimum 0.080 inches.
   c. Channels to have one side with a continuous slot with in-turned lips.
      1) Width: 1-5/8 inches.
      2) Depth and configuration as necessary for loading conditions.
3. Fittings: Same material as system major components.
4. Fasteners:
   a. Nuts: Toothed groves in top of nuts to engage the in-turned lips of channel.
   b. Bolts: Hex-head cap screws.

c. Same material as system major components.

5. End caps:
   a. At each exposed end of each piece mounted on walls, or guardrails, or suspended from framing 7 feet or less above the floor or platform.
      a) Plastic for all exposed ends 7 feet or more above floor or platform.
      b) Plastic or metallic for all other exposed ends.
6. Schedule:
   a. Interior wet areas: Aluminum.
      1) Including the following rooms or areas:
         a) Pump vault.
   b. Exterior areas: Aluminum.
   c. All other areas not listed above: Hot-dipped galvanized steel.
7. Provide dissimilar materials protection in accordance with Specification Section 09 96 00.
8. Repair all cut ends or otherwise damaged areas of galvanized steel in accordance with ASTM A780.

K. Fall Protection Rail System.
   1. Unirail Horizontal Lifeline System by Capital Systems.
      a. Or equal.
   2. Provide substrate anchorage.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32 - 1/16 inches nominal radius.

C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Shop Connections:
   1. Stainless steel connections subject to corrosive environments or immersion service will be subject to the following enhanced visual and welding requirements:
      a. Fabricator
         1) Fabricator shall have QC program and procedures in place to avoid cross contamination with carbon steel products and material.
      b. Weld Procedures
         1) Weld procedures shall be qualified for all positions that will be welded, qualified by testing in accordance with applicable welding code AWS D1.6 requirements.
         2) Procedure Qualification Record (PQR) shall document all essential variables to perform consistent quality welds. PQR shall include maximum heat input per pass and shall be tested for CVN properties, macro hardness, and macro/micro hardness testing.
   2. Welds shall be continuous fillet type unless indicated otherwise.
   3. Full penetration butt weld at bends in stair stringers and ladder side rails.
   4. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
   5. Weld aluminum in accordance with AWS D1.2.
   6. Weld stainless steel in accordance with AWS D1.6.
   7. All headed studs to be welded using automatically timed stud welding equipment.

8. Grind smooth welds that will be exposed.

E. Make provisions to prevent carbon steel/free iron contamination of stainless steel surfaces (i.e., contact between carbon steel or iron and stainless steel component). Do not use cutting/grinding/drilling tools, wire brushes, or wire wheels on stainless steel that have been previously used on carbon steel or iron. Do not support or hang stainless steel weldments or fixtures with carbon steel cables or dunnage.

F. Passivate stainless steel items and stainless steel welds after they have been ground smooth, in accordance with ASTM A380/A380M.

G. Passivation Requirements:

1. For components/assemblies to be used only in dry air service environments:

a. No post-fabrication passivation treatments are required for external corrosion control.

H. Conceal fastenings where practicable.

I. Fabricate work in shop in as large assemblies as is practicable.

J. Tolerances:

1. Rolling:

a. ASTM A6.

b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.

2. Fabrication tolerance:

a. Member length:

1) Both ends finished for contact bearing: 1/32 inches.

2) Framed members:

a) 30 feet or less: 1/16 inches.

b) Over 30 feet: 1/8 inches.

b. Member straightness:

1) Compression members: 1/1000 of axial length between points laterally supported.

2) Non-compression members: ASTM A6 tolerance for wide flange shapes.

c. Specified member camber (except compression members):

1) 50 feet or less: -0/+1/2 inches.

2) Over 50 feet: -0/+1/2 inches (+1/8 inches per 10 feet over 50 feet).

3) Members received from mill with 75% of specified camber require no further cambering.

4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.

5) Camber shall be measured in fabrication shop in unstressed condition.

d. At bolted splices, depth deviation shall be taken up by filler plates.

1) At welded joints, adjust weld profile to conform to variation in depth.

2) Slope weld surface per AWS requirements.

e. Finished members shall be free from twists, bends and open joints.

1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

K. Fabricate grating, checkered plate, stairs, ladders and accessories using aluminum galvanized steel unless shown otherwise on Drawings.

1. Finish:

a. Mill, unless noted otherwise.
b. Coat surfaces in contact with dissimilar materials.
1) See Specification Section 09 96 00.

L. Fabricate grating in accordance with NAAMM MBG 531.
1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 inches.
2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 inches.
a. Tolerance: NAAMM MBG 531.
3. Removable sections: Not wider than 3 feet and not heavier than 100 pounds.
4. Ends and perimeter edges: Banded, with alternate bearing bars welded to band.
a. Provide full depth banding unless noted otherwise.
b. Banding at trenches and sumps to be 1/4 inches less than grating depth to allow for drainage.
5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 inches high toe plate.
6. Provide joints at openings between individual grating sections.
7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.

M. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.
1. Workmanship: Class 3 unless noted otherwise.

N. See Specification Section 09 96 00 for preparation and painting of ferrous metals and other surfaces.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
1. Refer to Specification Section 09 96 00 for surface preparation requirements.
1. All miscellaneous metal fabrication item surfaces shall be observed and approved, prior to application of shop-applied coatings, by a NACE Certified Coatings Specialist (CIP-3) with at least 4 years of experience in similar inspections.
a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.
b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.

B. Shop Applied Coating Application:
1. Refer to Specification Section 09 96 00 for coating requirements.
2. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of coatings.
3. Application of coatings shall be observed and certified by NACE certified coatings inspector.

C. Meet structural requirements of Specification Section 01 45 33 for inspection and testing items of structural nature.

D. Responsibilities of Testing Agency:
1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
a. Visually inspect all welds.
b. In addition to visual inspection, test 50% of full penetration welds and 20% of fillet welds with liquid dye penetrant or mag particle.
c. Test 20% of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.

d. For all surfaces intended to be immersed or intended to be water tight:
    1) 100% of all fillet welds shall be PT tested to ensure water-tight surfaces are free of surface defects that would create areas for MIC.
    2) 100% of all completed SS welds and material shall be passivated in accordance with ASTM A380/A380M.

2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
    a. Verify direct tension indicator gaps, if applicable.
3. Inspect structural steel which has been erected.
4. Inspect stud welding in accordance with AWS Code.
5. Prepare and submit inspection and test reports to Engineer.
    a. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
    1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
    1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
    1. Shim and grout as necessary.

B. Meet structural requirements of Specification Section 05 12 00 for erecting items of structural nature:
    1. Tolerances.
    2. Inspection and testing.

C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
    1. Plumb, align, and set structural steel members to specified tolerances.
    2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
    3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
    4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
        a. If not obvious from experience or from the Drawings, confer with the Engineer to identify those structural steel elements that must be complete before the temporary bracing system is removed.
    5. Remove and dispose of all temporary work and facilities off-site.

D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.

1. Report defects in work-in-place which may influence satisfactory completion of the work.
2. Absence of such notification will be construed as acceptance of work-in-place.

E. Field Measurement:

1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
2. Contractor responsible for the accurate fit of the work.

F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.

1. Use surveyor's level.
2. Notify Engineer of any errors or deviations found by such checking.

G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

H. Erect plumb and level; introduce temporary bracing required to support erection loads.

I. Use light drifting necessary to draw holes together.

1. Drifting to match unfair holes is not allowed.

J. Welding:

1. Comply with AWS D1.1, AWS D1.2, and AWS D1.6 (as applicable for the material welded) and requirements of this Section's "Fabrications" Article in "Part 2 - Products".
2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.
3. 100% of all completed stainless steel welds and material shall be passivated in accordance with ASTM A380/A380M.

K. Shore existing members when unbolting of common connections is required.

1. Use new bolts for rebolting connections.

L. Clean stored material of all foreign matter accumulated prior to the completion of erection.

M. Bolt Field Connections: Where practicable, conceal fastenings.

N. Field Welding:

1. Follow AWS procedures.
2. Grind welds smooth where field welding is required.
3. 100% of all completed stainless steel welds and material shall be passivated in accordance with ASTM A380/A380M.

O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.

1. Replace entire section.

P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

Q. Unless noted or specified otherwise:

1. Connect steel members to steel members with 3/4 inches diameter ASTM F3125, Grade A325 high strength bolts.
2. Connect aluminum to aluminum with 3/4 inches diameter stainless bolts.
3. Connect aluminum to structural steel using 3/4 inches diameter stainless steel bolts.
   a. Provide dissimilar metals protection.

4. Connect aluminum and steel members to concrete and masonry using stainless steel mechanical anchor bolts or adhesive anchor bolts unless shown otherwise.
    a. Provide dissimilar materials protection.
5. Provide washers for all bolted connections.
6. Where exposed, bolts shall extend a maximum of 3/4 inches and a minimum of 1/2 inches above the top of installed nut.
    a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

R. Install and tighten ASTM F3125, Grade A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
1. Provide hardened washers for all Grade A325 bolts.
    a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

S. After bolts are tightened, upset threads of ASTM A307 bolts or anchor bolts to prevent nuts from backing off.

T. Secure metal to wood with lag screws of adequate size with appropriate washers.

U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
1. Provide full penetration welded splices where continuity is required.

V. Provide each fabricated item complete with attachment devices as indicated or required to install.

W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
1. See Division 03 Specification Sections for non-shrink grout and anchorage.
2. Set and anchor each base plate to proper line and elevation.
    a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
        1) Wedges, shims and setting nuts to be of same metal as base plate they support.
        2) Tighten nuts on anchor bolts.
    b. Fill space between bearing surface and bottom of base plate with nonshrink grout.
        1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
    c. Do not remove wedges or shims.
        1) Where they protrude, cut off flush with edge of base plate.
    d. Fill sleeves around anchor bolts solid with non-shrink grout.

Y. Tie anchor bolts in position to embedded reinforcing steel using wire.
1. Tack welding prohibited.
    a. Coat projecting bolt threads and nuts with heavy coat of clean grease.
2. Anchor bolt location tolerance:
    a. Per Section 03 15 19.

Z. Install bollards as detailed on Drawings.
1. Fill pipe with concrete and round off at top.

AA. Provide abrasive stair nosings in each tread and landing of all concrete stairs and at each concrete stair landing having metal stair structure attaching to the concrete landing.
1. Center stair nosings in stair width.

BB. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.

1. Keep screw holes clean and ready to receive screws.

CC. Attach grating to end and intermediate supports with grating saddle clips and bolts.

1. Maximum spacing: 2 feet on-center with minimum of two per side.
2. Attach individual units of aluminum grating together with clips at 2 feet on-center maximum with a minimum of two clips per side.

DD. Coat aluminum surfaces in contact with dissimilar materials in accordance with Specification Section 09 96 00.

EE. Repair damaged galvanized surfaces in accordance with ASTM A780.

1. Prepare damaged surfaces by abrasive blasting or power sanding.
2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

FF. Anchor ladder to concrete structure with minimum 3/4 inches stainless steel anchor bolts with minimum 6 inches embedment.

GG. Anchor ladder to masonry structure with minimum 3/4 inches stainless steel anchor bolts with minimum 6 inches embedment.

1. When anchoring into masonry, fill masonry cores with grout at anchor locations and each masonry core within 8 inches of anchor
2. When anchoring into cavity wall construction, provide minimum 6 inches embedment into concrete or masonry back-up wall.
   a. At each anchor location, provide sleeve between back face of veneer and cavity face of concrete or masonry back-up wall.
   b. Cut cavity insulation as required and seal around sleeve.
      1) Sleeve to be 1 inch diameter schedule 40 stainless steel tubing, TP-304L, ASTM A269.
         a) Minimum wall thickness to be .065 inches.
      2) Continuously weld 4 by 4 by 1/4 inches Type 304 stainless steel, ASTM A666 flange onto each end of pipe.
         a) Drill 1 inch hole in flange to match pipe.
         b) Attach sleeve to concrete or masonry back-up with 1/4 inches concrete screw anchors.
      3) Grout solid, area around bolt where bolt penetrates veneer.
      4) Accurately locate sleeves to align with bolt locations on ladder.

HH. Anchor ladder to metal stud walls using minimum 1/2 inches stainless steel bolts, nuts and washers.

1. Verify that stud wall has been provided with adequate backing to accept ladder anchors.

II. Install ladder safety extension post in accordance with manufacturer's instructions.

1. Mount device opposite the climbing side.
2. Provide ladder safety extension device for all ladders unless noted otherwise.

JJ. Mount ladder fall protection system with rail offset from ladder side rail approximately 3 inches.

3.3 FIELD QUALITY CONTROL

A. Meet structural requirements of Specification Section 01 45 33 for inspection and testing items of structural nature.

3.4 CLEANING

A. After fabrication, erection, installation, or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings specified in Specification Section 09 96 00.

END OF SECTION

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SECTION 05 52 23
STEEL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel handrail, stair rail and guardrail.
2. Steel guardrail gates.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 05 50 00 - Metal Fabrications.
2. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. U.S. Department of Justice, Architectural and Transportation Barriers Compliance Board (Access Board):
   a. Americans with Disabilities Act (ADA):
      1) Accessibility Guidelines for Buildings and Facilities (ADAAG).
2. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   e. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   f. A276, Standard Specification for Stainless Steel Bars and Shapes.
   g. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   h. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
3. American Welding Society (AWS):
   a. D1.1, Structural Welding Code - Steel.
4. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 521, Pipe Railing Systems Manual.
5. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

B. Qualify welding procedures and welding operators in accordance with AWS.

1.3 DEFINITIONS

A. Hardware: As defined in ASTM A153/A153M.

B. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

C. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

D. Handrail: A horizontal or sloping rail intended for grasping by the hand for guidance or support.

E. Railing: A generic term referring to guardrail, handrail and/or stair rails.

F. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SUBMITTALS

A. Shop Drawings:

1. Fabrication and/or layout drawings.
   a. Plan showing profile, location, section and details of each railing, and type and details of anchorage system.
   b. Location and type of expansion joints.
   c. Materials of construction including shop-applied coatings.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.

B. Informational Submittals:

1. Certification of welders and welding procedures indicating compliance with AWS.
2. Certification that railings have been designed and fabricated to meet the loading requirements specified.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect from corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Welded railing systems:
   a. Any manufacturer meeting this Specification Section.
2. Galvanizing repair paint:
   a. ZRC Products.

2.2 MATERIALS

A. Pipe: ASTM A53, Types E or S, Grade B, or ASTM A501.

B. Steel Sheet, Bar (Pickets) and Plate: ASTM A36.

C. Stainless Steel Tubing and Pipe: ASTM A269, ASTM A312 or ASTM A554, Type 304 or 316.

D. Stainless Steel Bar and Plate: ASTM A276.

E. Galvanizing Repair Paint:

1. High zinc dust content paint for regalvanizing welds and abrasions.
2. Dried film shall contain not less than 95% zinc dust by weight.
3. ZRC Products "ZRC."

F. Expansion and Adhesive Anchors: See Specification Section 03 15 19.

G. Welding Electrodes: AWS D1.1, E70 Series.

2.3 FABRICATION

A. General:

1. Verify field conditions and dimensions prior to fabrication.
2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
   a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
   a. Ease exposed edges to a radius of approximately 1/32 inches.
   b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
4. Form exposed connections with flush, smooth, hairline joints, using galvanized steel splice locks to splice sections together or by welding.
5. Provide for anchorage of type indicated on the Drawings or as required by field conditions.
   a. Drill or punch holes with smooth edges.
   b. Shim plates: Stainless] steel.
      1) Same size and shape as base plate.
      2) Drilled to match base plate anchorage.
6. Design railing and anchorage system in accordance with NAAMM AMP 521 to withstand loading as required by the building code.
7. Design railings in accordance with accessibility requirements per the building code and ADAAG.

B. Custom fabricate pipe railings to dimensions and profiles indicated.

1. Guardrails:
   a. 1-1/2 inches nominal diameter pipe unless shown differently on drawings.
   b. Top rails and intermediate rails: Schedule 40.
   c. Vertical posts: Schedule 80.
2. Handrails mounted to walls or guardrail vertical posts: 1-1/4 inches nominal diameter Schedule 40 pipe.
3. Where details are not indicated, space intermediate rails to requirements of the building code or OSHA Standards, whichever requires the more restrictive design.
4. Space vertical posts as required by loading requirements but not more than 4 feet on-center.
   a. Avoid locating vertical posts at changes in direction of railing.
   b. Hold vertical post back from corner and provide radiused corners.
5. Space handrail brackets as required by loading requirements but not more than 4 feet on-center.
6. Base plate for vertical guardrail posts mounted to top of concrete surface:
   a. 3/8 x 6 x 6 inches square plate welded to the vertical post.
   b. Predrilled to accept four anchors.
7. Base plate for vertical guardrail post mounted to metal structure:
   a. 3/8 x 2-1/2 x 8 inches plate welded to the vertical post.
   b. Predrilled to accept two fasteners.

8. Mounting bracket for vertical guardrail post mounted to vertical concrete surface or web of metal structural member:
    a. Pair of 3/8 inches angles or bent plates welded to vertical posts.
    b. Predrilled to accept two fasteners each.
    c. Provide 1/4 x 4 inches high toe boards at elevated walkways and platforms, where indicated on the Drawings or required by OSHA Standards.
        1) Clearance between bottom of toe board and walking surface shall not exceed 1/4 IN.
    d. Guardrail gates:
        1) Constructed of same material and sizes as the guardrail system.
        2) Width of gate as shown on Drawings.
        3) Hinges:
            a) Self-closing.
                (1) Stainless steel torsion spring.
            b) Similar to Wagner, Model "IR100."
        4) Gate latch and stop:
            a) Spring-loaded pin latch.
                (1) Stainless steel spring.
            b) Similar to Wagner, Model "IR101."

C. Welded Railing Fabrication:
    1. All welding to be continuous in accordance with AWS D1.1.
        a. All welded railing joints shall have full penetration welds.
    2. All exposed welds to be ground and buffed smooth and flush to match and blend with adjoining surfaces.
        a. NAAMM AMP 521, Type 2.
    3. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
    4. Fit exposed ends of guardrails and handrails with solid terminations.
        a. Return ends of handrails to wall but do not attach to wall.
    5. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.

D. Install weeps to drain moisture from hollow sections of railing at exterior locations and in high humidity areas.
    1. Drill 1/4 inches weep hole in railings closed at bottom:
        a. 1 inches above walkway surface at bottom of posts.
            1) 1 inches above solid rod at removable railing sections.
        b. At low point of intermediate rails.
        c. Drill hole prior to galvanizing.
        d. Do not drill weep holes:
            1) In bottom of base plate.

E. Expansion Joints:
    1. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
        a. Top rail splices and expansion joints shall be located within 8 inches of post or other support.
        b. Where railings span building expansion joints; provide a railing expansion joint in the span crossing the building expansion joint.
    2. Provide expansion joints in any continuous run exceeding 20 feet in length.

a. Space expansion joints at not more than 40 feet on center.

3. Provide minimum 0.10 inches of expansion joint for each 20 feet length of top rail for each 25 DegF differential between installation temperature and maximum design temperature.
   a. Maximum expansion joint width at time of installation shall not exceed 3/8 inches.
      1) Provide additional expansion joints as required to limit expansion joint width.
4. Provide slip-joint with internal sleeve.
   a. Extend slip joint min 2 inches beyond joint at maximum design width.
   b. Fasten internal sleeve securely to one side
      1) Provide allen-head set screw located in bottom of rail.
      2) Rivets or exposed screw heads are not acceptable.

F. Finish:
   1. Hot-dip galvanize after fabrication.
   2. Powder coated:
      a. Hot-dip galvanize after fabrication.
      b. Prepare galvanized surfaces in accordance with ASTM D6386.
      c. PVDF powder coating:
         1) Minimum 70% resin content.
         2) Meet requirements of AAMA 2605.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation, inspect and verify condition of substrate.

B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

3.2 INSTALLATION

A. Install handrails and guardrails to meet loading requirements of the building code.

B. Install products in accordance with NAAMM AMP 521 and manufacturer's instructions.

C. Set work accurately in location, alignment and elevation; plumb, level, and true.
   1. Measure from established lines and items which are to be built into concrete, masonry or similar construction.

D. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
   1. Provide shims as required.

E. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.
   1. Lubricate expansion joint splice bar for smooth movement of railing sections.

F. Attach handrails to walls or guardrails with brackets designed for condition.
   1. Provide brackets which provide a minimum 1-1/2 inches clearance between handrail and nearest obstruction.
      a. Handrails shall not project more than 4-1/2 inches into required stairway width.
   2. Anchor handrail brackets to concrete or masonry walls with 1/2 inches stainless steel adhesive anchors and stainless steel hex head bolts.

G. Anchor railings to concrete with minimum 1/2 inches stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract documents.

1. Where exposed, bolts shall extend minimum 1/2 inches and maximum 3/4 inches above the top nut.
    a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
    b. Bevel the top of the bolt after cutting to provide a smooth surface.

H. Anchor railings to metal structure with minimum 3/4 inches stainless steel bolts, nuts and washers.

I. Install toeboards to fit tight to the walking surface.
    1. Attach to railing vertical post with manufacturer's standard mounting clamp:
        a. Adjustable.
        b. Designed to engage in extruded slot on back of toeboard.
    2. Provide splice bars, corner splices and brackets:
        a. Manufacturer's standard items as required for a complete installation.
    3. Notch toeboards at base plates or other obstructions.
    4. Bottom of toeboard shall not exceed 1/4 inches above walking surface.

J. Repair damaged galvanized surfaces in accordance with ASTM A780.
    1. Properly prepare surface in accordance with galvanizing repair paint manufacturer's recommendations.
    2. Apply minimum 6 mils DFT of galvanizing repair paint in accordance with manufacturer's recommendations.

K. Prepare and paint railings in accordance with Specification Section 09 96 00.

L. Provide railings as required for stair construction identified in Specification Section 05 50 00.

M. Install guardrail gate plumb and level in location shown on Drawings.
    1. Center gate in opening.
    2. Top of gate to match top of guardrail.
    3. Fasten hinges to gate and jamb post:
        a. Minimum three, 1/4 inches stainless steel countersunk machine screws per leaf.
        b. Drill and tap into railing and gate vertical posts.
    4. Provide not less than two hinges per gate.
    5. Install gate latch and stop on strike side of opening.
        a. Fasten to gate with 1/4 inches stainless steel countersunk machine screws.
        b. Drill and tap into gate vertical post.
        c. Drill hole in railing vertical post to receive latch pin.
    6. Adjust to provide smooth operation:
        a. Self-closing and self-latching.

END OF SECTION

SECTION 05 52 43
WELDED ALUMINUM RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum handrail, stair rail and guardrail.
2. Aluminum guardrail gates.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 05 50 00 - Metal Fabrications.
2. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association (AA):
   a. ADM 1, Aluminum Design Manual.
2. American Society of Mechanical Engineers (ASME):
   a. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
3. ASTM International (ASTM):
   a. B108, Standard Specification for Aluminum-Alloy Permanent Mold Castings.
   b. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   c. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   d. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
   e. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
   f. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
4. American Welding Society (AWS):
   a. C5.5, Recommended Practices for Gas Tungsten Arc Welding.
   b. D1.2, Structural Welding Code - Aluminum.
5. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 521, Pipe Railing Systems Manual.
6. U.S. Department of Justice, Architectural and Transportation Barriers Compliance Board (Access Board):
   a. Americans with Disabilities Act (ADA):
      1) Accessibility Guidelines for Buildings and Facilities (ADAAG).
7. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

B. Qualifications:

1. Qualify welding procedures and welding operators in accordance with AWS and ASME Section IX.

1.3 DEFINITIONS

A. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

B. Handrail: A horizontal or sloping rail intended for grasping by the hand for guidance or support.

C. Railing: A generic term referring to guardrail, handrail and/or stair rails.

D. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SUBMITTALS

A. Shop Drawings:

1. Fabrication and/or layout drawings:
   a. Drawings showing profile, location, sections and fabrication details including all welding information of each railing.
   b. Type and details of anchorage.
   c. Location and type of expansion joints.
   d. Materials of construction, shop coatings and all third-party accessories.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation details.
3. Certification that railings have been designed and fabricated to meet the loading requirements specified.
4. Calculations:
   a. Calculations shall be performed, sealed, signed and dated by a registered professional structural engineer licensed in the State of Idaho.
   b. Calculations shall be specific to this Project and shall include all assumptions, references and design interpretations used to achieve the results obtained by the Engineer.
   c. Reduction in load criteria is not acceptable as reason for deviation from sizes indicated in the Specification.

B. Informational Submittals:

1. Certification of welders and welding procedures indicating compliance with AWS requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Welded railing systems:
   a. Golden Railing - Welded Railing System.
   b. Moultrie Manufacturing Company - Wesrail Welded.
   c. Peak-to-Peak Engineered Railings - Welded Railing System.

d. Tuttle Railing Systems - TABCO 3000.

2.2 MATERIALS

A. Alloy 6061-T6 or Alloy 6005-T6.

1. ASTM B209 for sheets and plates.
2. ASTM B221 and ASTM B308 for shapes - beams, channels, angles, tees, and zees.
3. ASTM B247 for forgings.

B. Alloy 6063-T5 or T6.

1. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.

C. Fittings:

1. Cast Aluminum, ASTM B108.
2. Machined aluminum: 6063-T5 or T6 alloy.

D. Shims: Aluminum of same alloy as component being shimmed.

E. Fasteners: See Specification Section 05 50 00.

F. Expansion and Adhesive Anchors: See Specification Section 03 15 19.

G. Electrodes for Welding:

1. Aluminum: AWS D1.2.
2. Filler alloy 5356 or 4043.

2.3 FABRICATION

A. General:

1. Verify field conditions and dimensions prior to fabrication.
2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
   a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
   a. Ease exposed edges to a radius of approximately 1/32 inches.
   b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
   c. Drill or punch holes with smooth edges.
4. Form exposed connections with flush, smooth, hairline joints, using stainless steel or aluminum splice locks to splice sections together or by welding.
   a. Ease the edges of top rail splices and expansion joints and remove all burrs left from cutting.
5. Provide for anchorage of type indicated on Drawings or as required by field conditions.
   a. Drill or punch holes with smooth edges.
6. Design railings and anchorage system in accordance with NAAMM AMP 521 to resist loading as required by the building code.
   a. Maximum allowable stresses per AA ADM 1.
7. Design railings in accordance with accessibility requirements per the building code and ADAAG.

B. Custom fabricate railings to dimensions and profiles indicated.

1. Guardrails:
   a. Posts: Minimum 1 1/2 inches nominal diameter Schedule 80 pipe.

1) Space vertical posts as required by loading requirements but not more than 4 feet on center.
2) Avoid locating vertical posts at changes in direction of railing.
3) Hold vertical post back from corner and provide radiused corners.

b. Rails: Minimum 1 1/2 inches, maximum 2”, nominal diameter Schedule 40 pipe.
1) Top of rail to be 42” above finish floor or grate.
2) Where details are not indicated, space intermediate rails to requirements of the building code or OSHA Standards, whichever requires the more restrictive design.
3) Maximum intermediate rail spacing to prevent a 21” in diameter sphere to pass through.

2. Handrail: Minimum 1 1/4 inches nominal diameter Schedule 40 pipe.
a. Outside diameter: 1 1/2 inches minimum, 2 inches maximum.

3. Space handrail brackets as required by loading requirements but not more than 4 feet on center.

4. Space vertical posts as required by loading requirements but not more than 4 feet on center.

5. Mounting:
a. Welded flanges:
1) For surface mounting to top of concrete:
a) 3/8 x 6 x 6 inches square plate.
b) Predrilled to accept four anchors.
2) For mounting to flange of metal structure:
a) 3/8 x 3 x 8 inches plate.
b) Predrilled to accept two fasteners.

b. Cast or machined flanges:
1) Provide manufacturer’s standard cast or machined flanges or brackets as necessary for conditions shown on Drawings.
2) Railing posts shall be secured using socket-head stainless steel set screws.
a) Bolts, TEK screws, rivets, or adhesive are not acceptable.
3) Flanges and brackets shall allow for removal of railing sections where removable railings are indicated on the Drawing.

c. Reinforce posts as necessary for loads specified.
1) Completed assembly shall be designed to withstand the loading capacity specified.

6. Toeboards:
a. Minimum 2” tall.
b. 1/4 inches thick by 4 inches high extruded toeboard with stiffener ribs.
1) Wagner “IR94102” kickplate.

c. Guardrail gates:
1) Constructed of same material and sizes as the guardrail system.
2) Width of gate as shown on Drawings.
3) Hinges:
a) Cast aluminum.
b) Self-closing.
(1) Stainless steel torsion spring.
c) Similar to Wagner, Model "IR100."
4) Gate latch and stop:
a) Cast aluminum.
b) Spring-loaded pin latch.

(1) Stainless steel spring.

c) Similar to Wagner, Model "IR101."

C. Railing Fabrication:

1. All railings are to be welded systems.
2. Use wire welding for all joints.
3. All welding to be continuous in accordance with AWS C5.5 and AWS D1.2.
   a. All welded railing joints shall have full penetration welds unless noted otherwise.
4. All exposed welds to be ground smooth and flush to match and blend with adjoining surfaces.
   a. NAAMM AMP 521, Type 2.
5. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
6. Finishing joints with filler is not acceptable.
7. Provide flush weld fittings using locking weld connectors or coped drive-on connectors.
8. Fit exposed ends of guardrails and handrails with solid terminations.
   a. Return ends of handrail to wall, but do not attach to wall.
   b. Where guardrail terminates at a wall, provide a vertical post or end-loop 4 inches off the wall to center of vertical member.
9. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.
10. Provide weeps to drain water from hollow sections of railing at exterior and high humidity conditions.
    a. Drill 1/4 inches weep hole in railings closed at bottom:
       1) 1 inches above walkway surface at bottom of posts set in concrete.
       2) 1 inches above base flange or reinforcing spud where applicable.
       3) At low point of intermediate rails.
    b. Do not drill weep holes:
       1) In bottom of base flange.
11. Expansion joints:
    a. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.
       1) Top rail splices and expansion joints shall be located within 8 inches of post or other support.
       2) Where railings span building expansion joints; provide a railing expansion joint in the span crossing the building expansion joint.
    b. Provide expansion joints in any continuous run exceeding 20 feet in length.
       1) Space expansion joints at not more than 40 feet on center.
    c. Provide minimum 0.10 inches of expansion joint for each 20 feet length of top rail for each 25 DEGF differential between installation temperature and maximum design temperature.
       1) Maximum expansion joint width at time of installation shall not exceed 3/8 inches.
          a) Provide additional expansion joints as required to limit expansion joint width.
    d. Provide slip-joint with internal sleeve.
       1) Extend slip joint min 2 inches beyond joint at maximum design width.
       2) Fasten internal sleeve securely to one side.
          a) Provide Allen-head set screw located in bottom of rail.
          b) Rivets or exposed screw heads are not acceptable.

D. Finish:

1. Mill.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation, inspect and verify condition of substrate.

B. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.

1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Install handrails and guardrails to meet loading requirements of the building code.

B. Install products in accordance with manufacturer's instructions.

C. Set work accurately in location, alignment and elevation; plumb, level and true.

1. Measure from established lines and items which are to be built into concrete, masonry or similar construction.

D. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.

1. Provide shims as required.

E. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer.

1. Lubricate expansion joint splice bar for smooth movement of railing sections.

F. Provide removable railing sections where indicated on Drawings.

G. Attach handrails to walls or guardrail with brackets designed for condition:

1. Provide brackets which provide a minimum 1/4 inches clearance between handrail and nearest obstruction.
   a. Handrails shall not project more than 4-1/2 inches into required stairway width.
2. Anchor handrail brackets to concrete or masonry walls with stainless steel adhesive anchors with stainless steel hex head bolts.
3.

H. Anchor railings to concrete with stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract Documents.

1. Where exposed, bolts shall extend minimum 1/2 inches and maximum 3/4 inches above the top nut.
   a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
   b. Bevel the top of the bolt after cutting to provide a smooth surface.

I. Anchor railings to metal structure with stainless steel bolts, nuts and washers.

J. Install toeboards to fit tight to the walking surface.

1. Attach to railing vertical post with manufacturer's standard mounting clamp:
   a. Adjustable.
   b. Designed to engage in extruded slot on back of toeboard.
2. Provide splice bars, corner splices and brackets:
   a. Manufacturer's standard items as required for a complete installation.
3. Provide spacer bar and U-bracket where necessary for toeboard to clear mounting flange.
4. Bottom of toeboard shall not exceed 1/4 inches above walking surface.

K. Coat aluminum in contact with dissimilar metal or concrete in accordance with Specification Section 09 96 00.

L. Provide railings as required for stair construction identified in Specification Section 05 50 00.

M. Install guardrail gate plumb and level in location shown on Drawings.

1. Center gate in opening.
2. Top of gate to match top of guardrail.
3. Fasten hinges to gate and jamb post:
   a. Minimum three, 1/4 inches stainless steel countersunk machine screws per leaf.
   b. Drill and tap into railing and gate vertical posts.
4. Provide not less than two hinges per gate.
5. Install gate latch and stop on strike side of opening.
   a. Fasten to gate with 1/4 inches stainless steel countersunk machine screws.
   b. Drill and tap into gate vertical post.
   c. Drill hole in railing vertical post to receive latch pin.
6. Adjust to provide smooth operation:
   a. Self-closing and self-latching.

END OF SECTION

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DIVISION 06

WOOD, PLASTICS, AND COMPOSITES

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rough carpentry.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 15 19 – Anchorage to Concrete
2. Section 07 61 13 - Metal Roofing.
3. Section 07 62 00 - Flashing and Sheet Metal.
4. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. The Engineered Wood Association (APA):
   a. PRP-108, Performance Standards and Qualification Policy for Structural Use Panels.
   b. U450, Storage and Handling of APA Trademarked Panels.
   c. Y510, Plywood Design Specification.
2. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
   c. D4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
   d. D4444, Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters.
   e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
3. American Wood Protection Association (AWPA):
   a. M2, Standard for Inspection of Preservative Treated for Industrial Use.
   b. M3, Standard for the Quality Control of Preservative Treated Products for Industrial Use.
   c. M4, Standard for the Care of Preservative-Treated Wood Products.
   d. T1 Processing and Treatment Standard.
   e. U1, Use Category System: User Specification for Treated Wood.
4. American National Standards Institute/Single Ply Roofing Industry (ANSI/SPRI):
   a. ES-1, Wind Design Standard for Edge Systems Used with Low Slope Roof Systems.
5. Environmental Protection Agency (EPA).
6. FM Global (FM):
   a. 1-49, Property Loss Prevention Data Sheets - Perimeter Flashing.
7. National Institute of Standards and Technology (NIST):
   a. PS 1, Quantitative NMR (Benzoic Acid).
   b. PS 20, American Softwood Lumber Standard.
8. Underwriters Laboratories, Inc. (UL):
   a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

B. Qualifications:

1. Wood Treatment Plant: AWPA M3.
2. Treated Wood Inspection: AWPA M2.

C. Miscellaneous:

1. Factory marking:
   a. Lumber:
      1) Identify type, grade, moisture content, inspection service, producing mill, and other qualities specified.
      2) Marking may be omitted, as allowed by the building code, if certificate of inspection is provided for each shipment.

1.3 SUBMITTALS

A. Shop Drawings:

1. Fabrication drawings of all fabricated items.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions for all products specified.
3. Certifications:
   a. Chemicals used in treatment process are registered with and approved by EPA.
   b. Moisture content of material prior to treatment: 25% maximum.
   c. Material has been kiln-dried after treatment (KDAT) to the moisture content specified.
4. Documentation of treatment of treated material in accordance with standards referenced.

1.4 DELIVERY AND STORAGE

A. Delivery, storage and handling of untreated wood products:

1. Lumber: As recommended by the grading agency indicated on the grade stamp.
2. Plywood: APA U450.

B. Delivery, storage, handling and disposal of treated wood products: AWPA M4.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 MATERIALS

A. General:

1. Lumber (for framing, blocking, nailers, furring, grounds and similar members):
   a. NIST PS 20.
   b. Species:
      1) Treated material: As indicated in the appropriate AWPA standard.
         a) Provide species of FRTM as necessary to achieve UL rating listed.
   c. Grade:
      1) For nominal sizes up to and including 2 x 4: Standard and better.
      2) For nominal sizes up to 2 inches thick and wider than 4 inches: #2 and better.

B. Preservative Treated Material:

1. Moisture content:

a. Prior to treatment: 25%.
b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
1) Lumber: 19% maximum.
2) Plywood: 18% maximum.
2. Preservative:
a. Waterborne: AWPA T1.
b. As indicated in the appropriate AWPA standard.
3. Pressure-treat material in accordance with AWPA U1.
4. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

C. Fire-Retardant Treated Material (FRTM):
1. Acceptable manufacturer:
a. Hoover Treated Wood Products, Inc.:
1) Interior: "Pyro-Guard".
2) Exterior: "Exterior Fire-X".
2. Maximum moisture content:
a. Prior to treatment: 25%.
b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
1) Lumber: 19% (KDAT).
2) Plywood: 15% (KD-15).
3. Fire-retardant preservative:
a. Provide protection against decay:
1) EPA registered for use as a wood preservative.
b. Shall not bleed-through or adversely affect bond of any finish.
4. Pressure-treat material in accordance with AWPA U1.
5. UL Classified:
a. FR-S, UL 723.
b. Exterior: No increase in classification when subjected to the Standard Rain Test, ASTM D2898.
c. Provide UL mark on each piece of FRTM.
6. Maximum flame spread rating: 25, ASTM E84.
7. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify measurements, dimensions, and shop drawing details before proceeding.

B. Coordinate location of studs, nailers, blocking, grounds and similar supports for attached work.

C. Eliminate sharp projections which would puncture roofing, flashing or underlayment material.

3.2 ERECTION AND INSTALLATION

A. General:
1. Provide preservative treated material for all wood used:
a. Outside building.
b. Below grade.
2. Provide fire-retardant treated material for all wood used:

a. Inside building.
b. Exterior building walls.
c. Roof construction.
d. Parapet walls.
e. Roofing nailers.

B. Attach work securely by anchoring and fastening as indicated or required to support applied loading.
1. Anchor wood to concrete using adhesive or expansion anchors as specified in Specification Section 03 15 19.
a. Separate wood from direct contact to concrete with polyethylene foam gasket strip.
1) Size: 1/4 inches by width of wood member.
2) Owens Corning "SillSealR".
2. Anchor wood to metal using bolts and nuts as specified in Specification Section 03 15 19.
3. Provide flat washers under all bolt heads and nuts.
4. Fasten plywood in accordance with APA recommendations.
5. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
6. Install fasteners without splitting of wood; predrill as required.
7. Do not drive threaded friction type fasteners.
8. Tighten bolts and lag screws at installation and retighten as required.

C. Set work to required levels and lines, plumb, true.
1. Shim as required.
2. Cut and fit accurately.

D. Provide wood grounds, nailers, or blocking where required for attachment of other work and surface applied items.
1. Form to shapes indicated or required.
a. FRTM lumber:
1) Do not rip or mill.
2) Cross-cutting and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
3) Resurfacing, planing or fabrication of special shapes or profiles shall be done prior to treatment.
b. FRTM plywood:
1) Cross-cutting, ripping and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
c. Light sanding of FRTM as permitted by UL to remove raised grain or prepare for finishing is allowable.
d. Field treat cuts and holes in preservative treated material in accordance with AWPA M4 and manufacturer's published recommendations.
2. Grounds:
a. Dressed, key beveled lumber minimum 1-1/2 inches wide of thickness required to bring face of ground even with finish material.
b. Remove temporary grounds when no longer required.
3. Install roofing nailers as necessary for attachment of flashing, curbs, fascia, coping, and related accessories:
a. Match height of nailers to insulation.

b. Anchor nailers to resist force of 300 PLF unless required otherwise by FM Global or roofing manufacturer.
   1) Metal decking attachment:
      a) Attach base nailer to metal roof deck using self-tapping stainless steel sheet metal screws (STSMS) with plate washers or with minimum 3/8 inches Type 304 stainless steel hex head bolts with nuts and washers.
      b) Countersink heads of bolts flush with top of nailer.
   2) Concrete decking attachment:
      a) Attach base nailer to concrete roof deck using minimum 3/8 inches stainless steel adhesive anchors with minimum 3 inches embedment.
      b) Countersink heads of bolts flush with top of nailer.
   3) Provide size and spacing of anchorage as required to meet loading criteria specified.
      a) Fasten blocking for perimeter flashing in accordance with ANSI/SPRI ES-1 and FM Global 1-49.
c. Provide 1/2 inches vent spaces between lengths of nailers.
d. Install nailers over vapor retarder.

E. When wood has been exposed to moisture allow to completely dry out prior to covering with additional wood or another material.

F. Correct or replace wood which shows bowing, warping or twisting to provide a straight, plumb and level substrate for applications of other materials.

END OF SECTION

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SECTION 06 82 00
FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fiberglass reinforced plastic (FRP) fabrications including but not limited to:
   a. Solid plate.
   b. Railings.
   c. Supporting structure design.

B. Related Specification Sections include but are not necessarily limited to:

1. 01 33 00 – Submittal Procedures

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI):
   a. A14.3, Safety Requirements for Fixed Ladders and Workplace Surfaces Package.
2. ASTM International (ASTM):
   a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
3. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

1.3 DEFINITIONS

A. Skid-resistant:

1. Manufacturer's standard applied abrasive grit coating.
2. Abrasive coated tape is not acceptable.

B. FRP: Fiberglass Reinforced Plastic.

C. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

D. Handrail: A railing provided for grasping with the hand for support.

E. Railing: A generic term referring to guardrail, handrail and/or stair rails.

1.4 SYSTEM DESCRIPTION

A. All fiberglass reinforced plastic support systems shall be designed by a registered professional structural engineer licensed in the State of Idaho.

B. The design criteria is as follows:

1. Uniform Live Load:100 psf
2. Wind Load: Minimum 35 psf
   a. The wind is calculated on the entire vertical surface of the bridge as if fully enclosed. Additionally, an upward wind force of 20 psf shall be applied to the deck area located at the quarter point of the bridge deck width.
3. Seismic Load: Seismic loads shall be determined according to the criteria specified in the latest AASHTO Bridge Design Specifications unless otherwise requested. Response Spectrum Analysis shall be performed in those designs that require complex seismic

investigation. All necessary response spectra information will be provided by the client for evaluation.

4. Snow Load: Sustained snow load conditions shall be evaluated for time dependent effects (creep and relaxation) and expected recovery behavior. The use of snow loads per the latest AASHTO Bridge Design Specifications shall be applied to the structure with consideration of local conditions.
5. Safety Factor: Under AASHTO, a safety factor of (4) shall be used for determining allowable stresses based on the ultimate strength of all FRP material.

C. Serviceability Criteria.

1. Service loads are used for the design of all structural members when addressing deflection and vibration issues. Criteria used in the design of FRP bridges are as follows:
   a. Deflection:
      1) Live Load (LL) deflection = L/500
      2) Lateral Wind Load (WL) deflection = L/500
   b. Vertical Frequency (fn): = 5.0 Hz
      1) The fundamental frequency of the pedestrian bridge (in the vertical direction) without live load should be greater than 5.0 hertz (Hz) to avoid any issues with the first and second harmonics.
   c. Horizontal Frequency (fn): = 3.0 Hz
      1) The fundamental frequency of the pedestrian bridge (in the horizontal direction) without live load should be greater than 3.0 hertz (Hz) to avoid any issues due to side to side motion involving the first and second harmonics.

1.5 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Manufacturer's recommendations on reinforcing field cut openings.
2. Fabrication and/or layout drawings.
   a. Plan showing profile, location, section and details of each item including anchorage or support system(s).
   b. Locations and type of expansion joints.
   c. Materials of construction including shop applied coatings.
   d. Listing of all accessory items being provided indicating material, finish, etc.
3. Certifications:
   a. Certification of Structural Engineer's qualifications.
   b. Certification that all components and systems have been designed and fabricated to meet the loading requirements specified.
4. Manufacturer's full line of colors available for each component.

B. Informational Submittals:

1. Complete design calculations of all supporting structure and fastening conditions.
   a. Design calculations to be for information only.
   b. Engineer will not review or take any action on submittal.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle each item to preclude damage.

B. Store all items on skids above ground.

1. Keep free of dirt and other foreign matter which will damage items or finish and protect from corrosion and UV exposure.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, The FRP bridge manufacturer shall be an ISO9001:2015 accredited company for the design and manufacture of FRP structural components and systems. The company shall have been in the business of design and fabrication of bridges for a minimum of ten years. Company shall provide a list of five successful bridge projects, of similar construction, each of which has been in service at least three years. List the location, bridge size, Owner and contact reference for each bridge.

2.2 SPAN

A. Bridge span will be 57’ 0” (straight line dimension) and shall be measured from each end of the bridge structure.

2.3 WIDTH

A. Bridge width shall be 4’ 0” and shall be measured from the inside face of structural elements at deck level.

2.4 BRIDGE SYSTEM TYPE

A. Bridges must be designed as a FRP Composite Truss Span.

2.5 CAMBER

A. Bridges shall be precambered to eliminate initial dead load deflection.

2.6 RAILINGS

A. Railings.

1. Railings should be a minimum of 42” above the floor deck for pedestrian and bicycle use.

B. Safety Rails.

1. Continuous horizontal safety rails of channel shall be located on the inside of the trusses. The Maximum opening between the safety rails shall not be greater than 4”. If preferred, vertical pickets can be provided upon request.

C. Toeplates.

1. Continuous horizontal toe plates of 3” channel shall be located on the inside of the trusses near deck level.

2.7 MATERIALS

A. Fiberglass Reinforced Plastic (FRP):

1. All members shall be fabricated from pultruded FRP composite profiles and structural shapes as required.
2. Color: To be selected by Engineer when more than one color is available for any one component.

B. FRP bridges shall be fabricated from high-strength E-glass and isophthalic polyester resin unless otherwise specified. Weathering and ultraviolet light protection shall be provided by addition of a veil to the laminate construction. Minimum characteristic design strengths, developed per ASTM D7290, are as follows:

	CH662	CH860	TQ240	
Tension (LW) (psi)	67,236	59,150	63,968	ASTM D638
Compression (LW) (psi)	71,285	70,888	43,363	ASTM D6641
Shear (In-plane) (psi)	9,954	9,773	9,977	ASTM D5379

Shear (interlaminar) (psi)	4,442	3,969	4,189	ASTM D2344
Young's Modulus (LW) (psi)	4.35E+06	4.41E+06	3.87E+06	ASTM D6641 & D638 (Taken as the mean of the lessor of the two)

C. FRP Thickness:

1. The minimum thickness of FRP composite shapes shall be as follows unless otherwise specified: square tube members (closed type shape) shall be 0.25 in. Wide-flange beams, channel sections, and angles (open type shapes) shall be a minimum thickness of 0.375 in. standard plate shall be a minimum thickness of 0.375 in.

D. FRP Connections:

1. All FRP bridge connections shall be classified as concentric bolt bearing & contain at least (2) bolts for load transfer. All connections shall be experimentally determined via full section joint component testing.
   a. Tubes/solids shall be investigated @ 0-deg. with 3/4” A307 bolts
   b. Channels shall be investigated @ 0,45,90-deg. with 3/4” A307 bolts
   c. Channels shall be investigated @ 45,90 -deg. with 3/8” plate & 3/4” A325 bolts
   d. All tube/solid capacities shall utilize a tube with bonded solid plug in the bearing area
   e. All channel capacities shall utilize (2) channels
   f. Tests with plates shall use a section of channel as the doubler plate in the bearing area
   g. All capacities shall be measured utilizing (2) bolts except CH860 0 -deg. (3 bolts)
2. The FRP bridge manufacturer shall provide test data showing the joint configurations achieve all stipulated characteristic values when analyzed in accordance with ASTM D7290. The minimum allowable characteristic values are as follows:

Component / Orientation	Characteristic Value
TQ240/SQ024 @ 0 -deg. (Compression)	73,433 lbs.
TQ240/SQ024 @ 0 -deg. (Tension)	29,186 lbs.
CH662 @ 0 - deg. (Tension)	33,886 lbs.
CH662 @ 90 - deg. (Tension)	33,253 lbs.
CH662 @ 90 - deg. w/ 3/8" Plate (Tension)	51,094 lbs.
CH662 @ 45 - deg. (Tension & Compression)	36,018 lbs.
CH662 @ 45 - deg. w/ 3/8" Plate (Tension & Compression)	65,810 lbs.
CH860 @ 0 - deg. (Tension)	50,151 lbs.
CH860 @ 90 - deg. (Tension)	30,439 lbs.
CH860 @ 90 - deg. w/ 3/8" Plate (Tension)	53,981 lbs.
CH860 @ 45 - deg. (Tension)	39,247 lbs.
CH860 @ 45 - deg. w/ 3/8" Plate (Tension)	72,439 lbs.
CH860 @ 45 - deg. (Compression)	48,886 lbs.
CH860 @ 45 - deg. w/ 3/8" Plate (Compression)	62,308 lbs.

E. Hardware.

1. Bolted connections shall be A307 hot-dipped galvanized steel unless otherwise specified. Mounting devices shall be galvanized or stainless steel.

F. Fiberglass Solid Plate Skid-resistant Surfacing.

2.8 FABRICATION

A. General:

1. Fabrication of the bridge structure shall be per ANSI/ACMA Code of Standard Practice, Industry Guidelines for Fabrication and Installation of Pultruded FRP Structures unless otherwise noted.

B. Railings:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

END OF SECTION

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DIVISION 07

THERMAL AND MOISTURE PROTECTION

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SECTION 07 17 00
BENTONITE COMPOSITE SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bentonite composite sheet waterproofing system.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. D751, Standard Test Methods for Coated Fabrics.
   b. D903, Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
   c. D4632/D4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   d. D5887/D5887M, Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
   e. D5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.
   f. D5993, Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners.
   g. D6768/D6768M, Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

B. Qualifications:

1. Installer(s) to have completed a minimum of three other projects of similar scope within last three years.
2. Installer shall be approved in writing by manufacturer.

1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Jointing, sealing, and fastening details not shown on Drawings but required by the Project.
2. Certification of installer's qualifications.
3. Manufacturer authorized representative written documentation of substrate acceptability.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Carlisle Coatings & Waterproofing.
2. Tremco Commercial Sealants & Waterproofing.

2.2 MANUFACTURED UNITS

A. Bentonite Composite Sheet Waterproofing:

1. Sodium bentonite clay evenly distributed and bonded to composite geotextile fabric and HDPE film.
2. Carlisle “CCW MiraCLAY GM”.

B. Accessory Items:

1. Flashing, sealant, termination bars, fasteners, and ancillary items as required by manufacturer for a complete, waterproof system.

C. Protection Board: Extruded Polystyrene.

1. Thickness: Minimum 1/4 inches.
2. Fan-fold, 4 feet by 50 feet.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Bentonite Composite Sheet Waterproofing:

1. Bentonite mass/unit area: ASTM D5993, minimum 1 pound/SF.
2. Swell index: ASTM D5890, minimum 24 ml.
3. Tensile strength: ASTM D6768/D6768M, 30 pound/IN MARV.
4. Permeability: ASTM D5887/D5887M, $5x10^{-11}$ M/SEC maximum.
5. Elongation: ASTM D4632/D4632M, 150%.
   a. Measure at maximum peak in the weakest principle direction.
6. Hydrostatic head pressure: ASTM D751, 228 feet.
7. Adhesion to concrete: ASTM D903, 17.7 pound/IN.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ensure that concrete has been cured in accordance with manufacturer's recommendations.

B. Remove free standing water, debris, and loose material.

C. Fill all voids, seal all penetrations, and remove all sharp fins and ridges.

D. Seal all penetrations in accordance with Specification Section 01 73 20.

E. Repair concrete surfaces in accordance with Specification Section 03 35 00.

1. Fill voids and remove all sharp fins and ridges.

3.2 INSTALLATION

A. Install continuous waterproofing membrane to all below grade surfaces where indicated on Drawings.

1. Terminate top of membrane within 4 inches of finished grade.
2. Extend membrane over footings and seal to bottom edge of footing.

B. Install products in accordance with manufacturer's instructions.

1. Provide granular bentonite cants at horizontal-to-vertical junctions.
2. Overlap upper courses over lower courses with minimum 4 inches lap.
3. Stagger seams minimum 12 inches.
4. Seal around all penetrations in accordance with manufacturer's recommendations.

C. Provide all waterstops, sealant, termination bars, fasteners and other accessories required for a watertight installation.

D. Avoid panel damage during pouring and vibrating of concrete for slab work and during backfilling operations for wall work.

E. Install protection board immediately prior to backfilling.

1. Temporarily secure protection board using manufacturer's recommended tape or adhesive.
   a. Do not mechanically fasten or penetrate waterproofing in any way.

3.3 FIELD QUALITY CONTROL

A. Manufacturer authorized representative shall inspect substrate for acceptability prior to application of waterproofing membrane.

1. Provide written documentation of inspection, including identification of deficiencies and remedies provided.

B. Manufacturer authorized representative shall inspect completed installation prior to installation of protection board or backfilling.

1. Perform flood testing of installed membrane to demonstrate water-tightness.

3.4 PROTECTION

A. Protect panels as required from pre-hydration caused by precipitation or other construction activities.

B. Protect system from physical damage until backfilling is completed.

C. Repair or replace damaged materials in accordance with manufacturer's recommendations as necessary to ensure a waterproof installation.

END OF SECTION

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SECTION 07 21 00
BUILDING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Building insulation.
   a. Does not include roof insulation or roof vapor retarder; see Specification Section [_____].

B. Related Specification Sections include but are not necessarily limited to:

1. Section 09 29 00 - Gypsum Board.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. C272/C272M, Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
   b. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   c. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   d. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   e. C665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
   f. D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
   g. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
2. Underwriters Laboratories, Inc. (UL):
   a. Building Materials Directory.

B. Mock-Ups:

1. Provide insulation for mock-ups required in Specification Section 04 22 00.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Manufacturer's recommendations on sealants, tapes and mastics.

B. Informational Submittals:

1. Certification from insulation manufacturer stating that insulation proposed is acceptable for intended use per the Drawings.

1.4 SITE CONDITIONS

A. For purposes of this Specification Section, design frost line for this Project is 36”inches below grade.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Granular insulation.
   a. Base:
      1) Grace Masonry Products.
2. Rigid extruded polystyrene board insulation:
   a. Dow.
   b. DiversiFoam Products.
   c. Owens Corning.
3. Rigid polyisocyanurate foam board insulation:
   a. Dow.
   b. Dyplast Products.
   c. Hunter Panels.
   d. Other manufacturers meeting the requirements of this Specification Section.
4. Vapor retarder:
   a. Raven Industries, Inc.
   b. Reef Industries, Inc.
   c. Fortifiber Building Systems Group, Inc by Henry Company.
   d. Alumiseal.

2.2 MATERIALS

A. General:

1. Foam plastic insulation used in buildings and structures shall comply with the requirements of the building code.
   a. Surface burning characteristics: ASTM E84.
   b. Flame spread index: Maximum 75.
   c. Smoke developed: Maximum 450.

B. Granular Insulation:

1. Water resistant vermiculite.
2. Provide where indicated.

C. Rigid Polystyrene Board Insulation:

1. Extruded: ASTM C578, Type IV.
   a. Water vapor transmission: ASTM E96/E96M, 1.1 perm-IN maximum.
   b. Water absorption: ASTM C272/C272M, 0.3% maximum.
   c. Thermal resistance: ASTM C518 at 75 degrees F mean temperature, 5.0/IN.
2. Provide insulation designed for intended use.
   a. Perimeter insulation and protection board.
      1) Similar to Dow "Styrofoam PERIMATE."
      2) Compressive strength: ASTM D1621, 30 psi.
      3) Thickness:
         a) Perimeter insulation: 2 inches.
         b) Protection board: 1 inch.
      4) Edges:

a) Long edge: Shiplap.
b) Short edge: Square.

D. Rigid Polyisocyanurate Foam Board Insulation:
1. ASTM C1289, Type 1 Class 1.
2. Compressive Strength: ASTM D1621, Minimum 25 psi.
3. CFC and HCFC free.
4. Ozone depletion potential: 0.
5. Foil facers or foil/kraft/foil facer on front and back side.
a. Facers shall be treated to eliminate corrosive action of aluminum foil contacting masonry, mortar and concrete.
6. Fire resistance: ASTM E84.
a. Flame spread: Less than 25.
b. Smoke developed: Less than 450.
7. Provide insulation designed for intended use.

E. Sealant and Mastic (for setting polystyrene and/or polyisocyanurate insulation board): Manufacturer's recommended standard.
1. Unfaced:
a. ASTM C665, Type 1.
2. Minimum thickness as noted on Drawings.

F. Vapor Retarder:
1. Fire rated, reinforced, 3 ply, Class 1 material.
2. Perm rating: Not exceeding 0.035 grains/HR-FT^2-IN-Hg when determined in accordance with ASTM E96/E96M.
3. Griffolyn "TX-1200FR."

G. Vapor Retarder Tape: As recommended by vapor retarder manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Insulate full thickness over surfaces to be insulated.
2. Fit tightly around obstructions, fill voids.
3. Cover all penetrations (electrical junction boxes, switch boxes, piping, conduits, etc.) with insulation, taking care not to compromise the workings of the device.
4. Fit butted joints of batt or blanket insulations tightly together.
5. Apply single or double layer to achieve total thickness.
a. If double layer is provided, stagger all joints minimum 12 inches.
6. Do not use broken or torn pieces of insulation.
7. Install so that completed installation is vapor tight.
a. Seal all joints.
b. Seal to abutting materials to maintain vapor retarder integrity.
c. Provide manufacturer’s recommended vapor retarder tape for use with faced batt insulation or separate vapor retarder.
1) If vapor retarder tape fails to adhere to any surface, apply sprayed-on adhesive as recommended by tape manufacturer to promote adhesion.

d. Provide manufacturer's recommended solvent-free sealant compatible with insulation board for rigid board insulation.

1) Tape is not acceptable for use with rigid board insulation.

C. Rigid Insulation at Perimeter Below Grade and Under Slab:

1. Install insulation below grade on outside face of foundation walls.

a. Install in mastic with tight joints.

2. Install insulation below grade on inside face of foundation walls.

a. Install in mastic with tight joints.

b. Install insulation horizontally under floor slabs.

1) Extend minimum 24 inches from exterior foundation walls.

3. Where footings are located below the design frost line, extend insulation down to the design frost line.

a. Where indicated on the Drawings, extend beyond the design frost line.

4. Where footings are located at the design frost line, extend insulation down to top of footing or as indicated on Drawings.

5. Protect insulation from damage and/or displacement during backfilling [and/or pouring of floor slab].

3.2 FIELD QUALITY CONTROL

A. Repair or replace damaged insulation and/or vapor retarder as directed by Engineer.

END OF SECTION

SECTION 07 61 13
METAL ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standing seam metal roofing.
2. Standing seam fascia system.
3. Snow retention system.
4. Sheet metal work required for roofing.
5. Curbs for roof penetrations of ductwork, flues etc.

B. Related Specification Sections include but are not necessarily limited to:

1.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Architectural Manufacturers Association (AAMA):
   a. 621, Voluntary Specifications for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
2. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. A792/A792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   c. C209, Standard Test Methods for Cellulosic Fiber Insulating Board.
   d. C1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   e. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
   f. D1970/D1970M, Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
   g. D4833/D4833M, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
   h. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   i. E1592, Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
   j. E1646, Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
   k. E1680, Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.
   l. E1745, Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
   m. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Architectural Sheet Metal Manual.
4. Underwriters Laboratories, Inc. (UL):
   a. Building Materials Directory.

b. Fire Resistance Directory.
c. 580, Standard for Tests for Uplift Resistance of Roof Assemblies.
d. 790, Standard Test Methods for Fire Tests of Roof Coverings.
e. 1256, Standard for Fire Test of Roof Deck Constructions.

B. Qualifications:
1. Manufacturer shall have minimum of 10 years of experience in the production of structural standing seam metal roofing.
a. All structural components of the roof system shall be designed and sealed by registered professional structural engineer licensed in the State of Idaho.
2. Installing contractor shall be licensed or approved in writing by manufacturer.
3. Contractor and installer shall have minimum of seven years of experience in the installation of structural standing seam metal roof systems similar to system specified.
4. Contractor and installer shall have successfully completed two projects of similar size, scope and complexity within past two years.

C. Mock-Ups:
1. Prior to start of permanent roof construction construct mock-ups of roofing system.
a. Mock-ups shall be of sufficient size to properly display all components required by the roofing system.
b. Mock-ups shall be a minimum 5 feet x 5 feet in size.
c. Provide multiple mock-ups as required.
2. Mock-ups shall incorporate all components, specified and/or required but not specified, needed for a complete water and airtight roofing fascia, system.
a. Components include, but are not limited to:
1) Vapor retarder, thermal barrier sheathing, roof insulation, ice dam membrane.
2) Roofing panels, including mounting system and seaming.
3) All fascia conditions.
4) All flashing and counterflashing conditions, including:
a) Eave, rake, hip and ridge conditions.
b) Roof/vertical wall intersections.
c) Roof penetrations.
d) All reglet conditions.
5) All miscellaneous clips, angles, plates, brackets, closures and sealants.
6) Gutter and downspouts.
7) Snow retention system.
3. Panels shall be same panels as specified or approved for Project.
a. Exact color is not necessary; however, Contractor is to label each exposed component to identify final installed color of component.
4. Step construction to allow observation of all components.
5. Construct additional mock-ups or rework existing mock-ups until acceptable to Engineer.
6. Maintain mock-ups at project site until Engineer approves removal of mock-ups.
7. Approved mock-ups to constitute minimum acceptable standard of quality for actual construction.

D. Completed roof system to be inspected by roof manufacturer's authorized factory trained representative prior to issuance of roof warranty.

1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Steep Slope: Having a pitch of 3:12 or greater.

C. Low Slope: Having a pitch less than 3:12 but greater than 1/4:12.

D. PVDF: Polyvinylidene fluoride.

1.4 SYSTEM DESCRIPTION

A. Prefinished, field-insulated, structural standing seam metal roof system, including but not limited to:

1. Vapor retarder.
2. Roof insulation.
3. Structural standing seam metal roof panels.
   a. Roof panel support and attachment system to be determined by standing seam roof manufacturer.

B. All flashing and miscellaneous trim required for a complete water and airtight system, including but not limited to:

1. Reglets.
2. Flashing.
3. Counterflashing.
4. Sealants.

C. Flat metal fascia system.

D. Prefinished aluminum soffit panels.

E. Snow retention system.

1.5 SUBMITTALS

A. Shop Drawings:

1. Fabrication and/or layout drawings:
   a. Manufacturer prepared computer generated Drawings showing anchorage, flashing, jointing and all other accessories required and all special detailing required by the system.
      1) Minimum plan scale: 1 inch = 8 feet.
      2) Minimum detail scale: 1-1/2 inches = 1 foot.
   b. Provide complete erection plan for each building structure with all details and sections referenced, all penetrations shown, expansion joints shown, detailed and referenced, and all special conditions identified, referenced and detailed.
   c. Erection plan to identify limits of each different substrate material (decking).
   d. Provide distinction between factory and field assembled work.
2. Product technical data including:
   a. Manufacturer data sheets on each component, including masonry reglets used in the roof system.
   b. Acknowledgement that products submitted meet requirements of standards referenced.
      1) Certification by manufacturer that roofing assembly being supplied has been successfully tested under UL 580 procedures and has achieved a Class 90 rating.
3. Test results:
   a. UL 580, Class 90 test data.
   b. ASTM E1592 test results.

1) Provide results of tests conducted in accordance with ASTM E1592 for panel size and gage and clip type and spacing similar to panels and clips being used.

c. ASTM E1646 and ASTM E1680 test results.

d. Concentrated load test data.

1) Load test to be conducted on panel size, gage and with clip spacing as required.

4. Qualifications:

a. Manufacturer: Provide structural engineer qualifications.

b. Contractor:

1) Certification of approval or license to install product from manufacturer.

2) Certification of experience.

3) Listing of projects completed in the past two years with similar scope.

4) Completed projects information to include, square footage of roofing installed, dollar value of roofing installed, manufacturer and type of roofing installed and contact name and telephone number of building Owner.

c. Installer: Provide qualifications of all personnel expected to be working on the Project.

5. Roofing manufacturer's letter of approval for insulation proposed for use.

6. Warranty: Sample language of manufacturer's warranty to be provided on this Project.

7. Structural Engineer's sealed and signed calculations certifying that system structural components meet the requirements for lateral, upward and downward loads specified.

B. Samples:

1. General: Tag, identify and provide statement regarding use for all fasteners, anchor clips, closures and sealants.

2. Roof panel:

a. Two samples, full width, 24 inches long.

b. Provide color selected or specified when possible.

3. Fasteners.

4. Anchor clips.

5. Closures, (both metal and non-metallic).

6. Masonry reglet.

7. Factory and field applied sealants.

8. Color samples:

a. For initial preliminary color selection, provide manufacturer's color chart showing all colors available.

b. For final color selection, provide two 2 inches x 3 inches colored metal samples, for each color selected during the initial color selection.

C. Contract Closeout Information:

1. Operation and Maintenance Data:

a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:

1. Final warranty.

1.6 WARRANTY

A. Provide 20 year complete system warranty, including material for air and weather tightness of entire roof assembly signed by manufacturer.

1. Warranty limits shall meet the minimum load capacity requirements of ASTM E1592.

B. Provide manufacturer's 20 year warranty on panel finish against fading, chipping, cracking and peeling of the panel exterior finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Metal roofing products specified are manufactured by Centria.

B. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide a system with similar profile, standing seam height, spacing, construction and factory applied finish.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Metal roofing:
   a. CENTRIA by NCI Building Systems.
   b. Merchant & Evans, Inc. - ZIP-RIB.
   c. IMETCO.
   d. Other manufacturers capable of providing structural standing seam system and profiles similar to that specified will be considered.
2. Vapor retarder:
   a. Griffolyn by Reef Industries, Inc.
3. PVDF resin:
   a. PPG IdeaScapes - DURANAR.
   b. Valspar - Fluropon.
   c. Arkema - Kynar 500.
   d. Solvay - Hylar 5000.
   e. Solvay - Hylar 5000.
4. Snow retention system:
   a. S-5! Attachment Solutions by Metal Roof Innovations, Ltd.
5. Structural roof curbs:
   a. Thybar Corporation.
   b. The Pate Company.
   c.

2.2 MATERIALS

A. Roof Panels:

1. General:
   a. Galvalume steel, ASTM A792/A792M, Class SS, Grade 50B.
      1) Painted surfaces: AZ50.

B. Fascia Metal: 22 GA to match gutter material, finish and color.

C. Perimeter Trim, Panel Closures, Flashing and Counterflashing: Material and factory applied finish to match roof panels.

D. Undelayment: GAF Tigerpaw or equal

1. ASTM D226, ASTM D4869, Type II, and ASTM D8257.

E. Coverboard: GAF Densdeck or equal.

1. ASTM E84, ASTM E136, and ASTM E119.[

F. Fasteners: 300 series stainless steel, ASTM F593.

G. Intermediate Support System:

1. Galvanized steel: ASTM A653/A653M, Class SS, Grade 50, G90.

H. Sealant: Manufacturer's standard non-curing butyl.

2.3 ACCESSORIES

A. Gutters and Downspouts:

1. General:
   a. Galvalume steel, ASTM A792/A792M, Class CS.
      1) Painted surfaces: AZ50.
      2) Unpainted surfaces: AZ55.
      3) Galvanized steel, ASTM A653/A653M, Class CS, G90.
      4) Minimum thickness: 22 GA.
      5) All exposed surfaces to have finish and color to match roofing metal.
      6) Exposed surfaces of gutter to match roofing metal; exposed surfaces of downspouts to match adjacent wall surface.
2. Gutters:
   a. "Style D" gutter per SMACNA Figure 1-2.
      1) Seamless except for expansion joints.
   b. Gutter straps and eave closure flashing: Match gutter material, finish and color.
   c. Mesh debris screen:
      1) Provide mesh debris screen mounted in stainless steel frame.
      2) Screen: 1/4 x 1/4 inches stainless steel, ASTM A580/A580M.
      3) Stainless steel frame: ASTM A240/A240M, Type 304.
3. Downspouts:
   a. SMACNA Figure 1-32E.
      1) Seam on concealed side of downspout.
      2) Provide gutter to downspout connection per SMACNA Figure 1-33B, Detail 1.
   b. Hanger straps: Material and finish to match downspouts.

B. Vapor Retarder:

1. ASTM E1745, Class A rated.
2. Water vapor permeance: ASTM E96/E96M, 0.03 maximum.
3. Tensile strength: ASTM D882, 275 feet-LB.
4. Puncture strength: ASTM D4833/D4833M, 72 feet-LB.
5. Griffolyn Type 105.
6. Vapor retarder tape: As recommended by vapor retarder manufacturer.

C. Roof Insulation:

1. Rigid polyisocyanurate foam board.
   a. ASTM C1289, Class I, Type II.
   b. Compressive strength: 20 psi minimum.
   c. Density: 2 pcf minimum.
   d. Thermal resistance (R-Value): 7.2/IN.
   e. Water vapor transmission: ASTM E96/E96M, less than 1.0 perms.
   f. Water absorption: ASTM C209, less than 1.0%.
   g. Thickness noted on Drawings.
   h. Acceptable to roof manufacturer.

D. Roof Penetration Flashing:

1. Round penetrations:
   a. Premolded EPDM boot with metal collar.
   b. Buildex "DEK-TITE."

E. Flashing Curb:

1. Provided by metal roofing manufacturer.
2. One-piece completely seal welded prefabricated roof curb, including vertical flashing, and counter flashing, cricket on high side of penetration and flat pan fabricated to replace standing seam metal roof panel.
3. Size as required for penetration.
4. Bottom sloped to match roof.
   a. Level on top.
5. Minimum 16 GA galvannealed steel.
   a. Finish to match roof panel.

F. Foam and metal closures, sealant, gaskets, fasteners, washers, clips, angles, and all miscellaneous trims shall be provided by roofing manufacturer, fabricated for the specific condition as required.

G. Snow Retention System:

1. Mechanical non-penetrating system for sloped metal roof systems to prevent ice and snow from sliding off roof.
   a. Provide splice fittings for a continuous installation.
2. Snow retention system shall consist of aluminum extrusion secured to the standing seam with non-penetrating stainless steel set screws having rounded points.
3. Aluminum:
   a. Finish: Manufacturer's standard finish.
   b. Extrusion to have receptacle in face to provide for insertion of prefinished sheet metal strip to match roofing color.
4. Snow/Ice clips:
   a. Aluminum or stainless steel.
   b. Provide with rubber foot on end that sits on the metal roof pan.
5. Metal Roof Innovations, Ltd. S-5! "ColorGard" system.

2.4 FABRICATION

A. General:

1. Fabricate with square, true corners, mitered and welded.
2. Fabricate trim, flashings and closure pieces to match panel profile and finish.
3. Hem all edges.
4. Fabricate panels in full length with no end laps.
5. Soffit panels shall be continuous length.
   a. Miter panels at corners and provide trim piece as required.
   b. Miscellaneous length pieces not acceptable.

B. Standing Seam Metal Roof Panels:

1. Profile: Centria "SRS" System.
2. Height of standing seam: 2 inches.
3. Gage: Minimum 24.
4. Width:

a. 18 inches.
b. Longitudinal stiffening elements to minimize oil canning.
5. System shall be designed as a true structural standing seam shape.
6. Finish:
a. PVDF based with minimum 70% resin.
b. Three-coat system having minimum 0.8 mil epoxy primer coat on both sides of panel with a 0.8 mil PVDF resin color coat and a 0.8 mil PVDF resin clear top coat on the exterior side of the panel.
c. Meet or exceed requirements of AAMA 621.
d. Smooth finish.
e. Color:
1) To be selected from manufacturers full range of primary and secondary colors.
a) Does not include exotic, metallic flake or iridescent colors.
7. Concealed fasteners:
a. Provide concealed fasteners in all locations.
b. If exposed fasteners are required by the roof panel manufacturer, because of location, constructability issues or other critical design requirement, finish of fastener shall match roof panel finish.
1) Exposed fasteners are to be approved by Engineer.
c. The use of deflection limiter devices is not allowed.

C. Intermediate Support System:
1. Roof panel anchor clips:
a. Manufacturer's standard one-piece clip suitable for condition.
1) Two-piece clips are acceptable if required by roofing manufacturer.
b. Minimum 16 GA steel.
1) Galvanized, ASTM A653/A653M, G90.
2. Roof panel manufacturer shall be responsible for designing and providing all necessary intermediate "Z" or "hat-shaped" or other miscellaneous support members as required to transfer roof panel loads into building roof framing members.
a. Design in accordance with building code and loads specified.
3. Bearing plates:
a. Sized by roofing manufacturer for roof loading indicated.
b. Minimum 16 GA steel.
1) Galvanized, ASTM A653/A653M, G90.

2.5 SOURCE QUALITY CONTROL

A. Roof assembly to be Class A roof covering assembly per UL 1256.

B. Structural Testing:
1. The system shall be designed to safely resist the positive and negative loads per the building code and as shown on Drawings.
2. Structural-uniform uplift load capacity of the panel system shall be determined in accordance with ASTM E1592.
a. The factor of safety on the test results shall be 1.65 for the panel, batten or clip ultimate loads with no increase for wind.
b. The factor of safety for fasteners shall be 3.0 for one single fastener per clip, 2.25 for two fasteners per clip and 4.0 inches masonry.
c. Design uplift capacity for conditions of gage, span or loading other than those tested may be determined by interpolation of test results.

1) Extrapolation of conditions outside the range of the tests is not acceptable.

d. Deflection shall be L/180 for positive loading.

C. Water Penetration: No uncontrollable leakage at minimum 6.4 psf when tested in accordance with ASTM E1646.

D. Air Infiltration: Maximum 0.00 SCFM/SQFT when tested at 4.0 psf differential pressure when tested in accordance with ASTM E1680.

E. Fire Resistance/Wind Uplift Rating:

1. UL 790, Class 1.
2. UL 580, Class 90.

F. The panels shall withstand a 250 pound concentrated load applied to a 4 square inches area at the center of the panel at mid span between supports with no panel deformation, rib buckling, or panel sidelap separation which will adversely affect the weather tightness of the system.

G. Support roofing panels on top of roof insulation using bearing plates attached to the structural frame or connect to manufacturer-provided intermediate support system.

1. Bearing plate and standing seam roof panel anchor clip attachment is to be determined by the roofing manufacturer and shall take precedent over this Specification.
   a. Provide attachment to roof structural frame or deck as required for loading criteria specified.
2. Roof panel anchor clips shall be designed to allow thermal movement of the panels except where specific fixed points are indicated.
   a. Roof panel manufacturer shall be responsible for determining fixed point locations unless otherwise indicated.
3. Wood blocking shown at roof edge is strictly for attachment of miscellaneous flashings and shall not be used for any structural value.
4. Maximum spacing of roof clips shall be determined by manufacturer.

H. Roof panel manufacturer shall be responsible for designing and installing all necessary expansion joints in the roof system.

1. Where roof expansion joints occur, provide corresponding expansion joints in fascia, soffit and gutters.

2.6 MAINTENANCE MATERIALS

A. Provide Owner with 4 OZ of touch-up paint to match each different color used in the system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions, SMACNA (where referenced) and details shown on Drawings for a complete weathertight installation without waves, warps buckles or distortions.
   a. Provide all closures, trim, angles, plates, sealant, gaskets, fasteners, washers, etc., as necessary.
2. Attachments shall allow for thermal expansion and contraction.
3. Seal all joints as required for watertight installation.
4. Touch-up paint all damaged surfaces.

B. Standing Seam Roofing Panels:

1. Install in one continuous length from ridge to eave.
2. Hand crimp battens at each clip.

3. Seam panels and battens together with portable electric seaming machine supplied by the manufacturer.

C. Snow Retention System:

1. Install starting 2 feet from the eave edge of the roof.
2. Install system in continuous lengths using manufacturer provided splice fittings.
3. Mount to metal roofing utilizing clamps fastened to standing seam with non-penetrating bullet-nosed set-screws.
   a. Fasteners shall be compatible with roof panel system and shall not void any roof warranties.
   b. Fasteners shall not damage panel finish.
4. Install metal color strip in face of extrusion.
   a. Color strip to match color of standing seam roofing.
5. Provide snow/ice clips in each standing seam panel laterally across the roof or as recommended by manufacturer.
   a. Provide single clip for seam spacing of less than 16 inches and two clips for seam spacing 16 inches and greater.

D. Installation of Structural Roof Curbs:

1. Install roof curbs on decking.
2. Attach to metal decking using sheet metal screws.
   a. Provide fasteners at maximum 8 inches on-center with minimum of one fastener at each corner of curb.
3. Install flashing curb in accordance with roofing manufacturer's standard flashing details.
   a. Provide sheet metal flashing and counterflashing as required for weather-tight installation.

END OF SECTION

SECTION 07 62 00
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 SUMMARY

A. Related Specification Sections include but are not necessarily limited to:

1. Section 04 05 23 - Masonry Accessories.
2. Section 07 72 33 - Roof Hatches.
3. Section 07 92 00 - Joint Sealants.
4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Architectural Manufacturers Association (AAMA):
   a. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. American National Standards Institute/Single Ply Roofing Industry (ANSI/SPRI):
   a. ES-1, Wind Design Standard for Edge Systems Used with Low Slope Roof Systems.
3. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   b. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   c. B32, Standard Specification for Solder Metal.
   d. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. FM Global (FM).
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Architectural Sheet Metal Manual.

B. Qualifications:

1. Sheet metal fabricator shall have minimum 10 years experience in fabrication of sheet metal items similar to items specified.
2. Sheet metal installer shall have minimum five years experience installing sheet metal items specified.

1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. PVDF: Polyvinylidene fluoride.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
2. Fabrication and/or layout drawings.

a. Scaled drawing showing expansion joint locations, special conditions, profile, fastening and jointing details.
   1) Minimum plan scale: 1/8 inches = 1 foot.
   2) Minimum detail scale: 1-1/2 inches = 1 foot.
3. Fabricator qualifications.
4. Installer qualifications.

B. Samples:
1. Finish and color samples for each product specified for Engineer preliminary color selection.
2. For final color selection, provide two, 2 inches x 3 inches colored metal samples for each color selected during the preliminary color selection.

C. Informational Submittals:
1. Warranty: Manufacturer's sample warranty language.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pre-finished sheet metal:
   a. Carlisle SynTec Systems.
   b. Holcim Elevate.
   c. Petersen Aluminum Corporation.
2. Butyl sealant:
   a. Pecora Corporation.
   b. Sika.
   c. Tremco Commercial Sealants & Waterproofing.

2.2 MATERIALS

A. Sheet Metal:
1. Galvanized Steel: ASTM A653/A653M.

B. Fasteners: Non-ferrous compatible with sheet metal.

C. Solder: ASTM B32.

D. Sealants:
1. Non-curing Butyl Sealant:
   a. Pecora "BA-98".
   b. Sika "SikaLastomer 511".
   c. Tremco "TremPro JS-773".
2. Building sealants:
   a. See Specification Section 07 92 00.

E. Fasteners: Non-ferrous compatible with sheet metal.

F. Retainer Clips and Continuous Cleats: Galvanized steel or stainless steel.

G. Solder: ASTM B32.

H. Dissimilar Metal Protection: Comply with Specification Section 09 96 00.

I. Reglets: See Specification Section 04 05 23.
   a. All accessories to be factory mitered and welded.

2.3 FABRICATED ITEMS

A. General:

1. Shop fabricate items to maximum extent possible.
   a. Fabricate true and sharp to profiles and sizes indicated on Drawings.
      1) Shop fabricate and weld or solder all corners.
2. Pre-finished steel:
   a. Galvanized, G-60 or Galvalume, AZ-55.
   b. Thickness: Minimum 24 GA.
   c. Texture: Smooth.
   d. Coated on exposed face with PVDF coating having a minimum 70% resin content and a minimum 1.0 mil dry film thickness.
      1) Meet requirements of AAMA 2605.
      2) Color: From Manufacturer's available colors.

B. Retainer Clips and Continuous Cleats:

1. 16 GA galvanized steel.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction to Contractor in time to allow their installation.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions, SMACNA, and as indicated on Drawings.

B. Weld aluminum to achieve weathertight joints and required details.

1. Do not weld slip joints.
2. Touch-up damaged prefinished items.

C. Solder steel to achieve weathertight joints and required details.

1. Do not solder slip joints.
2. Touch-up damaged prefinished items.

D. Set top edges of membrane flashing and sheet metal flashing into reglets wherever practicable.

1. Surface applied terminations will be allowed only where specifically detailed or otherwise approved in writing by the Engineer.
2. Provide counterflashing at all reglets.
3. Seal reglets and counterflashings in accordance with Specification Section 07 92 00.

E. Fasten materials at intervals recommended by SMACNA.

F. Install slip joints to allow for thermal movement as recommended by SMACNA and manufacturer.

1. Maximum spacing: 10 feet on-center.
2. Provide slip joint 24 inches from corners.
3. Provide slip joint at each vertical expansion joint location in wall.
   a. Provide break in continuous cleat at each vertical expansion joint.
   b. The above expansion joints do not include brick veneer expansion joints.

G. Seal slip joints with two beads of non-curing butyl sealant on each side of slip joint overlap.

H. Form flashings to provide spring action with exposed edges hemmed or folded to create tight junctures.

I. Provide dissimilar metals and materials protection where dissimilar metals come in contact or where sheet metal contacts mortar, concrete masonry or concrete.

J. Provide all miscellaneous sheet metal items not specifically covered elsewhere, as indicated or required to provide a weathertight installation.

   1. Provide all components necessary to create weather-tight junctures between roofing and sheet metal work.

K. Provide sheet metal liner at exposed-to-view openings through roof deck, including but not limited to:

   1. Roof hatches: See Specification Section 07 72 33.

END OF SECTION

SECTION 07 72 33
ROOF HATCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roof hatches.
2. Hatch railing and gate system.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 15 19 - Anchorage to Concrete.
2. Section 05 50 00 - Metal Fabrications.
3. Section 07 62 00 - Flashing and Sheet Metal.
4. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. Occupational Safety and Health Organization (OSHA).

1.3 SUBMITTALS

A. Shop Drawings:

1. Scaled plan of roof showing location of all units and anchoring details.
   a. Minimum plan scale: 1/8 inches = 1 foot.
   b. Minimum detail scale: 1-1/2 inches = 1 foot.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Warranty.

1.4 WARRANTY

A. Roof Hatches: Manufacturer's standard five year warranty.

B. Hatch Rail System: Manufacturer's standard 25 year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Roof hatches in this project shall be fabricated.

2.2 MATERIALS

A. Sheet Metal:

1. Galvanized steel: ASTM A653/A653M, G90, Phosphatized.

B. Gaskets: Thermoplastic.

C. Gaskets: Extruded EPDM rubber.

D. Hardware: Type 316 stainless steel, unless noted otherwise.

E. Anchors:

1. Stainless steel.
2. Anchorage to metal framing or wood blocking: See Section 05 50 00.

2.3 FABRICATED UNITS

A. General:

1. Fully welded corners.
2. Hardware:
   a. Lifting eyes (x4 each hatch; one at each corner) for crane hoist.

B. Roof Hatches:

1. Curb:
   a. 12 inches high.
   b. 11 GA.
   c. Integral cap flashing.
   d. Mounting flange:
      1) Minimum 5-1/2 inches wide.
      2) Punched holes for fastening to roof deck.
2. Cover:
   a. Exterior: 11 GA.
   b. Internally reinforced.
      1) Minimum 40 psf live loading.
   c. Completely weather sealed and gasketed.
3. Finish: Galvanized.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely anchor units as appropriate.

1. Anchor to wood nailers with minimum 1/2 x 3 inch lag bolts.
2. Anchor to steel with minimum 1/2 inch stainless steel bolts, nuts and washers.
3. Maximum anchor spacing: 12 inches.
4. Provide attachment at each corner as a minimum.

B. Flash and counterflash to provide weathertight installation.

1. See Specification Section 07 61 13for roofing.

C. Provide dissimilar metals protection as required.

1. Refer to Specification Section 09 96 00.

3.2 SCHEDULE

See drawings.

SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sealing all joints which will permit penetration of dust, air or moisture.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
   a. 302.1R, Guide for Concrete Floor and Slab Construction.
2. ASTM International (ASTM):
   a. C834, Standard Specification for Latex Sealants.
   b. C920, Standard Specification for Elastomeric Joint Sealants.
   c. C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
3. NSF International (NSF):
   a. 61, Drinking Water System Components -- Health Effects.
4. Underwriters Laboratories, Inc. (UL).

B. Qualifications: Sealant applicator shall have minimum five years experience using products specified on projects with similar scope.

C. Mock-Ups:

1. Before sealant work is started, a mock-up of each type of joint shall be sealed where directed by the Engineer.
   a. The approved mock-ups shall show the workmanship, bond, and color of sealant materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.

1.3 DEFINITIONS

A. Defect(ive): Failure of watertightness or airtightness.

B. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.

C. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

D. "Interior wet areas": Room 101 Pump Room, Room 102 Valve Vault, Room 103 Utility.

E. "Seal," "sealing" and "sealant": Joint sealant work.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions.
c. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.

2. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
3. Certification of applicator qualification.

B. Test Results:

1. Provide adhesion test results for each sealant sample including adhesion results compared to adhesion requirements.
2. Manufacturer's authorized factory representative recommended remedial measures for all failing tests.

C. Samples:

1. Cured sample of each color for Engineer's color selection.
2. Color chart not acceptable.

D. Informational Submittals:

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in manufacturer's original unopened containers with labels intact: Labels shall indicate contents and expiration date on material.

1.6 PROJECT CONDITIONS

A. Schedule installation of sealant work after completion of penetrating item installation but prior to covering or concealing of openings.

B. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

C. Do not proceed with the installation of sealant materials when the ambient temperature is outside the manufacturer’s recommended limitations for installation and curing times as printed on the product label and product data sheet.

D. During installation provide masking and drop cloths to prevent sealant materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Compressible sealant:
   a. Schul International Company, LLC.
   b. Emseal by Sika.
   c. Norton.
   d. Sandell Moisture Protection Systems.
2. Expanding foam sealant:
   a. M-D Building Products, Inc.
   b. DAP Products, Inc.
   c. FAI International, Inc.
   d. Power Fasteners.
3. Polyether sealants:
   a. Master Builders Solutions.

b. Chem Link.
c. Tremco Commercial Sealants & Waterproofing.

4. Polysulfide rubber sealant:
   a. Pecora Corporation.
   b. Master Builders Solutions.
   c. PolySpec by ITW Polymers Sealants.
5. Polyurea joint filler:
   a. Dayton Superior Corporation.
   b. Euclid Chemical Company.
   c. L&M by LATICRETE International, Inc.
   d. Master Builders Solutions.
6. Polyurethane sealants:
   a. Pecora Corporation.
   b. Sika.
   c. Master Builders Solutions.
   d. Tremco Commercial Sealants & Waterproofing.
7. Backer rod, compressible filler, primer, joint cleaners, bond breaker:
   a. As recommended by sealant manufacturer.

2.2 MATERIALS

A. Sealants - General:

1. Provide colors matching materials being sealed.
2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
3. Nonsagging sealant for vertical and overhead horizontal joints.
4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
6. Sealant backer rod and/or compressible filler:
   a. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      1) Control joint depth.
      2) Break bond of sealant at bottom of joint.
      3) Provide proper shape of sealant bead.
      4) Serve as expansion joint filler.

B. Compressible Sealant:

1. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on front face with nonreactive release agent that will act as bond breaker for applied sealant.
   a. Schul "Sealtite B".
2. Adhesive: As recommended by sealant manufacturer.

C. Expanding Foam Sealant:

1. One or two component moisture cured expanding urethane.
2. Shall not contain formaldehyde.
3. Density: Minimum 1.5 pcf.
4. Closed cell content: Minimum 70%.
5. R-value: Minimum 5.0/IN.

6. Flame spread: Less than 25.
7. Smoke developed: Less than 25.

D. Polyether Sealant:

1. Silyl-terminated polyether polymer.
2. ASTM C920, Type S, Grade NS, Class 50, Use NT, M, A, and O.
   a. Master Builders Solutions MasterSeal 150.
   b. Chem Link DuraLink.
   c. Tremco Dymonic FC.

E. Polysulfide Rubber Sealant:

1. One or two component.
2. Meet ASTM C920.
   a. Pecora Synthacalk GC2+.
   b. PolySpec THIOKOL 2235.

F. Polyurea Joint Filler:

1. Two component, semi-rigid material for filling formed or saw-cut control joints in interior concrete slabs.
   a. Dayton Superior Corporation "Joint Fill, Joint Seal, Joint Saver II" as required for condition and recommended by manufacturer.
   b. Euclid Chemical Company "EUCO QWIK" joint.
   c. L&M "Joint Tite 750".
   d. Master Builders Solutions MasterSeal “CR100" control joint filler.
2. Comply with ACI 302.1R performance recommendations regarding control and construction joints.
3. Color: Gray.

G. Polyurethane Sealant:

1. One or two components.
2. Paintable.
3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A and O.
   a. Pecora Dynatrol-IXL, Dynatrol II, Urexpan NR-200, NR-201.
   b. Sika Chemical Corporation Sikaflex-1a, Sikaflex-2C NS/SL.
   c. Master Builders Solutions MasterSeal NP-1, NP-II, SL-1 SL-2.
   d. Tremco Dymonic or Dymeric, Vulkem 116,227,45,245.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

B. Use only compatible materials.

C. Where required by manufacturer, prime joint surfaces.

1. Limit application to surfaces to receive sealant.
2. Mask off adjacent surfaces.

D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions and UL requirements.

B. Clean all joints.

C. Make all joints water and airtight.

D. At changes in direction of joints, joint intersections and where sealant joints interface with other construction, install continuous sealant as necessary to ensure a weather-tight seal.

E. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 inches nor more than 1/2 inches unless recommended otherwise by the manufacturer.

F. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:

   1. Take care to not puncture backer rod and compressible filler.
   2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

G. Apply bond breaker where required.

H. Tool sealants using sufficient pressure to fill all voids.

I. Upon completion, leave sealant with smooth, even, neat finish.

J. Where piping, conduit, ductwork, etc., penetrate wall, seal each side of wall opening.

K. Install compressible sealant to position at indicated depth.

   1. Size so that width of material is twice joint width.
   2. Take care to avoid contamination of sides of joint.
   3. Protect side walls of joint (to depth of finish sealant).
   4. Install with adhesive faces in contact with joint sides.
   5. Install finish sealant where indicated.

L. Install expanding foam sealant to minimum 4 inches depth or thickness of wall being penetrated if less than 4 inches or as indicated on Drawings.

   1. Provide adequate backing material as necessary.
   2. Hold material back from exposed face of wall as necessary to allow for installation of backer rod and finish sealant.
      a. Allow expanding foam sealant to completely cure prior to installing backer rod and finish sealant.
   3. Trim off excess material flush with surface of the wall if not providing finished sealant.

3.3 SEALANT WORK

A. General:

   1. Work includes but is not limited to: Sealing all joints which will permit penetration of dust, air, or moisture.
   2. Refer to SCHEDULE for materials to be used.

B. Concrete joints:

   1. Flooring joints.
   2. Isolation joints.
   3. Joints between paving or sidewalks and building.
   4. Construction, control and expansion joints.
   5. Joints between precast roof units and between precast roof units and walls.
   6. Joints between precast wall panels.

C. Masonry:
   1. Masonry control joints.
   2. Between masonry and other materials.
D. Flashing, reglets and retainers.
E. Openings:
   1. Perimeters of door and window frames, louvers, grilles, etc.
   2. Door thresholds shall be set in a full bed of sealant.
   3. Glass and glazing: See specification Section 08 81 00.
F. Interior finishes:
   1. Perimeter and penetrations of sound insulated walls.
   2. Expansion and control joints in tile work.
G. Plumbing fixtures.
H. Penetrations of walls, floors and decks.
I. Other joints where sealant, expanding foam sealant or compressible sealant is indicated.

3.4 FIELD QUALITY CONTROL

A. Adhesion Testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: One test per every 1000 linear foot of joint sealed.
      b. Exterior precast concrete wall panels: One test per every 2000 linear foot of joint sealed.
      c. Chemical containment areas: One test per every 1000 linear foot of joint sealed.
      d. Building expansion joints: One test per every 500 linear foot of joint sealed.
      e. All other type of joints except butt glazing joints: One test per every 3000 linear foot of joint sealed.
      f. Manufacturer's authorized factory representative shall recommend, in writing, remedial measures for all failing tests.

3.5 SCHEDULE

A. Furnish sealant as indicated for the following areas:
   1. Exterior areas:
      a. Above grade: Polyurethane.
      b. Below grade: Polyurethane.
   2. Interior areas:
      a. Noncorrosive areas:
         1) Wet exposure: Polyurethane.
            a) See list of wet rooms above.
         2) Dry exposure: Polyurethane, unless noted otherwise.
   3. Immersion:
      a. Prolonged contact with or immersion in:
         1) Potable water:
            a) Polysulfide.
            b) NSF 61 approved.
         2) Nonpotable water: Polysulfide.
   4. Compressible sealant: Where indicated.
   5. Exterior wall penetrations: Expanding urethane foam, with finish sealant.

a. Finish sealant:
   1) Exterior side:
      a) Above grade: Polyether.
      b) Below grade: Polyurethane.
   2) Interior side:
      a) Noncorrosive area:
         (1) Wet exposure: Polyurethane.
         (2) Dry exposure: Polyurethane unless noted otherwise.

6. Interior concrete slab formed or saw-cut control joints: Polyurea joint filler.

END OF SECTION

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DIVISION 08

OPENINGS

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SECTION 08 11 00
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal doors and frames.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 08 70 00 - Finish Hardware.
2. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. National Association of Architectural Metal Manufacturers (NAAMM):
   a. Hollow Metal Manufacturers Association (HMMA).
3. Steel Door Institute (SDI):
   a. 117, Manufacturing Tolerances for Standard Steel Doors and Frames.
   b. All SDI publications.
4. Steel Door Institute/American National Standards Institute (SDI/ANSI):
   a. A250.6, Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
   b. A250.7, Nomenclature for Standard Steel Doors and Steel Frames.
   c. A250.8, Specifications for Standard Steel Doors and Frames.
   d. A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
   e. A250.11, Recommended Erection Instructions for Steel Frames.

B. Qualifications: Manufacturer must be current member of SDI, and NAAMM (HMMA).

C. Wipe coat galvanized steel is not acceptable as substitute for galvanizing finish specified.

1.3 DEFINITIONS

A. As identified in SDI/ANSI A250.7.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
2. Schedule of doors and frames using same reference numbers as used on Drawings.
3. SDI certification.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store doors and frames in accordance with SDI/ANSI A250.11.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Metal doors and frames:
   a. Ceco Door by ASSA ABLOY.
   b. Steelcraft by Allegion PLC.
   c. Curries by ASSA ABLOY.

2.2 MATERIALS

A. Steel Sheet: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

B. Frames: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

C. Supports and Reinforcing: Hot-dipped galvannealed steel, ASTM A653, A60 coating.

D. Inserts, Bolts and Fasteners: Manufacturer's standard.

E. Primer: Manufacturer's standard coating meeting SDI/ANSI A250.10.

F. Galvannealed Coating Repair: See Specification Section 09 96 00.

2.3 ACCESSORIES

A. Glass Panels in Doors:

1. Fixed, integral stops on exterior face.
2. Snap-in stops or stops secured with countersunk Phillips head machine screws on interior face.
3. Reinforce cut-out in door panel with minimum 20 GA galvannealed or galvanized steel channel.
4. Glass: See Specification Section 08 81 00.

B. Frame Anchors:

1. Jamb anchors:
   a. Masonry wire anchors: Minimum 0.1875 inches wire, galvanized.
   b. Existing wall anchor: Minimum 18 GA, galvanized.
   c. Stud partition and base anchors: Minimum 18 GA, galvanized.

2.4 FABRICATION

A. General:

1. SDI/ANSI A250.8.
2. Fabricate rigid, neat in appearance and free from defects.
3. Form to sizes and profiles indicated on Drawings.
   a. Beveled edge.
4. Fit and assemble in shop wherever practical.
5. Mark work that cannot be fully assembled in shop to assure proper assembly at site.
6. Continuously wire weld all joints, dress exposed joints smooth and flush.
7. Fabricate doors and frames to tolerance requirements of SDI 117.
8. Fit doors to SDI clearances.
9. All doors shall be handed.

10. Hinge cut-out depth and size on doors and frames shall match hinge specified in Specification Section 08 70 00.
11. Design and fabricate doors to requirements of the building code.

B. Hollow Metal Doors:

1. General:
   a. 1-3/4 inches thick.
   b. Fabricate with flush top caps.
      1) Thickness and material to match door face.
      2) Exterior doors: Seal weld top cap to door face and grind smooth and flush.
      3) Interior doors:
         a) Attach top cap to door with concealed fasteners or by welding.
         b) Factory seal if attached with fasteners.
         c) No exposed fasteners will be accepted.
   c. Continuously wire weld all joints and dress, smooth and flush.
2. Exterior:
   a. Doors 48 inches wide, or less: SDI/ANSI A250.8, Level 3, and physical performance level A, Model 2.
      1) Face sheet minimum thickness: 16 GA.
      2) Insulated: Minimum R10.
3. Interior:
   a. Doors 48 inches wide, or less: SDI/ANSI A250.8, Level 2, and physical performance level "B", Model 2.
      1) Face sheet minimum thickness: 18 GA.
   b. Sound insulated, minimum STC-35.

C. Hollow Metal Frames:

1. Door frames:
   a. Provide 2 inches face at all heads, jambs and mullions for frames in stud walls.
   b. Provide 4 inches face at head where noted on Drawings or required by wall construction.
   c. 26 GA galvannealed steel boxes welded to frame at back of all hardware cutouts.
   d. Steel plate reinforcement welded to frame for hinge, strikes, closers and surface-mounted hardware reinforcing.
      1) All plate reinforcement shall meet size and thickness requirements of SDI/ANSI A250.8.
   e. Split type frames not acceptable.
      1) All horizontal and vertical mullions and transom bars shall be welded to adjacent members.
   f. Conceal all fasteners.
   g. Frames shall be set up, all face joints continuously wire welded and dressed smooth.
   h. Exterior (up to 4 feet wide): 16 GA.
   i. Exterior (over 4 feet wide): 14 GA.
   j. Interior: 16 GA.
   k. Provide removable spreaders at bottom of frame.

D. Prepare for finish hardware in accordance with hardware schedule, templates provided by hardware supplier, and SDI/ANSI A250.6.

1. Locate finish hardware in accordance with SDI/ANSI A250.8.

2. See Specification Section 08 70 00 for hardware.
3. Prepare doors for swing direction indicated.
    a. Preparing doors for non-handed hinges is not acceptable.

E. After fabrication, clean off mill scale and foreign materials and prime with rust inhibiting primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install doors and frames in accordance with SDI/ANSI A250.11, the building code and manufacturer's instructions.

B. Plumb, align, and brace frames securely until permanently anchored.
    1. After completion of walls, remove temporary braces and spreaders.
    2. Anchor frames with minimum of three anchors per jamb.
        a. Number and location of anchors shall be in accordance with SDI and frame manufacturer's recommendations.

C. At new masonry or metal stud construction, place frames in conjunction with construction of walls or partitions.
    1. Masonry construction: Anchor frames using masonry wire anchors.
    2. Metal stud construction:
        a. Anchor frames using steel stud anchors.
        b. Attach wall anchors with self-tapping screws.

D. At concrete, precast concrete or existing masonry construction, place frames in rough opening using existing opening anchors.

E. Use plastic plugs to keep silencer holes clear during construction.

F. Immediately after erection, sand smooth rusted or damaged areas.
    1. Touch-up with rust-inhibiting primer.
    2. Finish paint door and frame in accordance with Specification Section 09 96 00.

G. Install three silencers on strike jamb of single door frame and two on head of double door frame.
    1. See Specification Section 08 70 00.

H. Protect doors and frames during construction.

END OF SECTION

SECTION 08 33 23
STEEL ROLLING OVERHEAD DOORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel rolling overhead doors.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI).
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
   a. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   e. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
   f. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   g. A501/A501M, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   h. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   i. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   j. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   k. E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
   l. F3125/F3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
4. Door & Access Systems Manufacturers' Association, International (DASMA):
   a. ANSI/DASMA 108, Standard Method for Testing Sectional Garage Doors and Rolling Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference.
5. International Energy Conservation Code (IECC).
6. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

7. Underwriters Laboratories, Inc. (UL):
    a. 325, Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

B. Qualifications:
    1. Installer to be licensed or approved in writing by door manufacturer.

1.3 DEFINITIONS

A. Installer or Applicator:
    1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
    2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
    1. Product technical data including:
        a. Acknowledgement that products submitted meet requirements of standards referenced.
        b. Manufacturer's installation instructions.
        c. Manufacturer's standard color charts.
    2. Schedule of doors using same reference number for openings as indicated on Drawings.
    3. Certifications:
        a. Certification of installer qualifications.
    4. Test Reports:
        a. Test report showing compliance with ASTM E330 or ANSI/DASMA 108 for the design pressure based on the wind speed specified.

B. Samples:
    1. Actual metal color samples of manufacturer's full line of colors available.

C. Contract Closeout Information:
    1. Operation and Maintenance Data:
        a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Steel rolling overhead doors:
        a. CornellCookson.
        b. Wayne Dalton.
        c. Overhead Door Corporation.
        d. Raynor Garage Doors.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Wind Load:
    1. Test door assemblies in accordance with ASTM E330 or ANSI/DASMA 108.
    2. Exterior doors:
        a. Determine static pressure in accordance with applicable test method.

b. Basic Wind Load Design Criteria:
1) Acting inward: 26 psf
2) Acting outward: 20 psf
3. Interior doors: 20 psf minimum.

B. Air Infiltration:
1. Meet ASHRAE 90.1 and IECC 2012/2015 C402.4.3.
2. Air leakage: <1.00 cfm/SQFT.

2.3 MATERIALS

A. Steel:
1. Hot dipped galvanized:
a. Fasteners: ASTM A153/A153M.
b. All other components: ASTM A123/A123M.
2. Bars, shapes, and plate: ASTM A36/A36M.
3. Pipe: ASTM A53/A53M or A501/A501M.
4. Tubing: ASTM A500/A500M.
5. Bolts and nuts: ASTM A307 or F3125/F3125M.

B. Weatherproofing:
1. Resilient: Neoprene or vinyl.
2. Brush type: Nylon or polypropylene.

C. Fasteners: Same material as door construction.

2.4 MANUFACTURED UNITS

A. Door Curtain:
1. Non-insulated flat profile.
a. Overhead Door Corp. "620 Series".
b. 2-5/8 inches high.
c. Minimum 0.040 inches thick.
d. Galvanized endlocks.
2. Bottom bar:
a. Two structural angles bolted back-to-back.
1) Minimum 1/8 inches thick.

B. Operation:
1. As scheduled on Door Schedule.

C. Guides:
1. Manufacturer's standard structural angle guide system for size of door specified.
a. Galvanized Steel.
b. Furnish curtain wind locks as necessary for design wind load.
2. Mounting:
a. Interior face of wall.
3. Cold-rolled guides are not acceptable.

D. Headplates:
1. Sized to support counterbalance assembly, curtain, motor operator and hood.
a. Field verify headroom and side clearances and coordinate motor operator mounting accordingly.

E. Counterbalance Assembly:
   1. Pipe barrel:
      a. Galvanized Steel.
      b. Maximum deflection: 0.03 inches/FT.
   2. Torsion springs:
      a. Oil-tempered helical torsion springs on cast anchors.
      b. 100,000 cycle.
   3. Adjustable tension wheel.
F. Hood:
   1. Minimum 24 GA.
   2. Air baffle extending full length.
G. Weatherstripping:
   1. Guide tracks: Exterior and interior weatherseal.
   2. Lintel: Brush-type weatherseal.
   3. Bottom seal:
      a. Manually-operated doors: Resilient weather seal.
H. Finish:
   1. Powder coat:
      a. Factory prime and finish coats.
      b. Prime coat: Minimum 0.2 mil baked-on prime paint.
      c. Finish coat: Minimum 0.6 mil baked-on polyester powder coat.
      d. Color: To be selected by Engineer from manufacturer's complete offering.
   2. Trim Pieces: Material and finish to match door curtain.

2.5 ACCESSORIES

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Installation shall be done by manufacturer's authorized representative.
C. Provide all required trim, weatherstripping, closures etc., for complete weather tight installation.
D. Adjust for proper counter balance.
E. Seal along bottom of vertical track (guides), seal the vertical joint between the two separate track angles (if not filled by welding) and seal all holes in vertical track (not being used for fasteners) to provide a completely weather tight track and door system.
   1. At fastener locations provide steel washers under bolt head to completely cover the slotted holes in the vertical track.
      a. Finish of steel washer shall match finish of track (guides).
F. Electrical disconnect and conduit and wiring from standard three pushbutton control to motor operator is provided in the Electrical Design.
G. Provide bracing for motor operator to eliminate vibration.

3.2 ADJUSTMENT

A. Prior to occupancy, adjust door for smooth operation.

END OF SECTION

SECTION 08 51 13
ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum windows.

B. Related Sections include but are not necessarily limited to:

1. Section 07 92 00 - Joint Sealants.
2. Section 08 81 00 - Glass and Glazing.
3. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Architectural Manufacturers Association (AAMA):
   a. 904, Voluntary Specification for Multi-Bar Hinges in Window Applications
   b. 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
   c. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. American Society of Civil Engineers (ASCE):
   a. 7, Minimum Design Loads for Buildings and Other Structures
3. ASTM International (ASTM):
   a. A924, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   b. C1363, Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
   c. E283, Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   d. E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
   e. E331, Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
4. American Welding Society (AWS):
   a. D1.2, Structural Welding Code - Aluminum.

1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data for framing system and major accessories including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Hardware being provided by window manufacturer.
c. Glass being provided by window manufacturer in factory glazed units.
d. Manufacturer's installation instructions.

2. Elevation drawings indicating window dimensions and details.

B. Samples:

1. After initial color selection, provide 2 x 3 inches minimum sample of each color and finish selected.

C. Informational Submittals:

1. Qualifications of testing laboratory.
2. Test results.
3. Warranty.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store units in vertical position off ground with wood spacers between each unit.

1.6 WARRANTY

A. Five year warranty of weathertightness of installation.

1. Air and water integrity and structural adequacy of units and hardware, including sealants and sealing within and around perimeter of installation.
2. Signed jointly by fabricator, installer, and contractor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Thermally broken windows:
   a. Wausau Metals Corp., 2250-T Series.
   b. Kawneer Company Inc., 8225-T Series.
   c. EFCO Windows, Series 510.

2.2 MATERIALS

A. Extruded Aluminum: 6063T5 alloy.

B. Sealants: As specified in Section 07 92 00.

C. Thermal Insulator: Poured in place polyurethane, self-adhering to adjacent aluminum surfaces.

D. Weatherstripping: Sponge neoprene.

2.3 ACCESSORIES

A. Flashing:

1. Minimum 0.040 inches aluminum.
2. Finish to match window frames.
3. Mill finish if concealed.

2.4 FABRICATION

A. General:

1. Fully degrease and clean members prior to assembly or application of protective coatings.
2. Weld by methods recommended by manufacturer and AWS D1.2 to avoid discoloration at welds.

3. Grind exposed welds smooth and restore finish.
4. Ease corners of cut edges to a radius of approximately 1/64 inches.
5. Conceal fasteners wherever possible.
6. Fit and assemble work at shop to maximum extent possible.
7. Maintain true continuity of line and accurate relation of planes and angles.
8. Provide secure attachment and support at mechanical joint, with hairline fit of contacting members.
9. Reinforce work as necessary to withstand wind loadings and to support system.
10. Separate dissimilar metal with paint or preformed separators to prevent corrosion.
    a. See Section 09 96 00.
11. Separate metal surfaces at moving joints with plastic inserts or other nonabrasive concealed inserts to permanently prevent freeze-up of joint.
12. Reinforce frames for hardware.
13. Structural steel reinforcement hot-dip galvanized after fabrication meeting G-90, ASTM A924, requirements.
14. Glass: See Section 08 81 00 for types of glass to be installed under this Section.

B. Fasteners:
1. Finish exposed fasteners to match finish of system.
2. Provide Phillips flat head screws where exposed.

C. Finish: AA-MA10C22A42, anodized.
1. Color: Natural aluminum. .

2.5 SOURCE QUALITY CONTROL

A. General Test Requirements:
1. Utilize independent testing laboratories specifically qualified to conduct all performance tests required.
2. Performance tests may be conducted in manufacturer's laboratories provided they are witnessed and certified by qualified independent testing laboratory personnel.
3. Perform all tests on "Test Unit":
    a. Full-sized window unit for project or a minimum 5 x 8 feet unit mounted in test chamber in exact accordance with job conditions including anchorage system, sealing, etc.
    b. Test unit to be completely assembled and glazed.
        1) Thermal tests may be conducted on 4 x 6 feet unit.
4. Test air infiltration first, water resistance second.
    a. Other tests may be in any order.
5. Test data on vertical pivot windows will be accepted for fixed windows for condensation resistance, thermal, temperature exposure and acoustical tests provided the fixed windows are the same as the vertical windows tested in the following respects:
    a. Same frame section (or same family of extrusions).
    b. Same basic metal mass inside and outside.
    c. Identical thermal break.
    d. Same type of glazing.

B. Test Requirements:
1. Air infiltration test:
    a. With sash and ventilators closed and locked, test in accordance with ASTM E283.
    b. Air infiltration, in CFM/FT of crack length, at pressure differential of 6.24 psf as follows:
        1) Fixed windows: 0.06 maximum, all others 0.10 maximum.

2. Water resistance test:
   a. Mount glazed unit in its vertical position, continuously supported around outside perimeter with sash and ventilators closed and locked.
   b. Test in accordance with ASTM E331.
   c. No uncontrolled leakage allowed, with pressure differential of 6.24 psf.
3. Uniform load deflection test:
   a. Test in accordance with ASTM E330.
   b. Subject unit to load of 25 psf applied to outside of window and 25 psf applied to inside of window.
   c. Maximum allowable deflection of any unsupported span: L/175.
   d. No glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms, or any other damage which would cause window to be inoperable will be allowed.
4. Uniform load structural test:
   a. Test in accord with ASTM E330.
   b. Subject unit to loads indicated below.
   c. Stabilize pressure and maintain it for minimum period of 10 seconds.
   d. No glass breakage, permanent damage to fasteners, hardware parts, support arms or activating mechanisms or any other damage which would cause window to be inoperable will be allowed.
   e. Maximum permanent deformation of any main frame, sash or ventilator member: 0.4% of its span.
   f. After performing Uniform Load Structural Test, increase loads 1-1/2 times and perform safety test.
   g. Design unit to withstand following design pressures acting normal to plane of wall, at applicable heights and locations.
      1) At height of 30 feet or less: 26PSF acting inward 20PSF acting outward.
5. Structural thermal barrier tension test:
   a. Test urethane filled sections of aluminum.
   b. Mechanically secure interior and exterior faces of 12 inches section in horizontal position.
   c. Apply heat tape to exterior face to control surface temperature at 180 degrees F 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
   d. Apply direct tension (pull) using a Universal testing machine set in 12,000 pound load range.
   e. Test results: No loss of bond at 4000 pound IN/IN/MIN.
6. Structural thermal barrier shear test:
   a. Test urethane filled sections of aluminum.
   b. Mechanically secure interior face of 12 inches section in vertical position.
   c. Apply heat tape to exterior face to control surface temperature at 180 degrees F 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.
   d. Apply load to exterior face by a bearing plate resting on top of exterior face, using Universal Testing machine set in 12,000 pound load range at a strain rate of 0.050 inches/IN/MIN.
   e. Test results: No loss of bond at 5500 pound loading.
7. Structural thermal barrier combined torsion and shear test:
   a. Test urethane filled sections of aluminum.
   b. Secure interior face of 12 inches section in horizontal position.

c. Apply heat tape to exterior face to control surface temperature at 180 degrees F 5 minutes before loading, as indicated by a thermocouple wire operated by an automatic controller.

d. Apply load to bearing plate centered on portion of glazing pocket to exterior side of thermal barrier, using a Universal Testing machine set in the 12,000 pound load range.

e. Test results: No loss of bond at 3900 pound load applied at strain rate of 0.05 inches/IN/MIN.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Set units plumb, level, and true to line.

C. Anchor securely in place.

D. Separate metal surfaces from sources of corrosion or electrolytic action.

1. See Section 09 96 00.

E. Set sill and base members in a bed of sealant.

F. Provide joint fillers or gaskets for weathertight construction.

G. Seal all joints within and at perimeter of system.

H. Provide sealant color to match finish of system at exposed locations.

I. Provide sealants compatible with aluminum system and recommended for use with this type of installation.

J. See Section 07 92 00 for sealants.

3.2 FIELD QUALITY CONTROL

A. Installation supervised or inspected by manufacturer's authorized representative.

END OF SECTION

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SECTION 08 70 00
FINISH HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Finish hardware.
2. Inspection and testing of door operation.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 08 11 00 - Hollow Metal Doors and Frames.

1.2 QUALITY ASSURANCE

A. All door hardware shall be provided by a single hardware supplier.

1. Hardware is to be provided under this Specification Section, unless noted otherwise, for doors specified in:
   a. Specification Section 08 11 00.

B. Referenced Standards:

1. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
   a. A156.1, Butts and Hinges.
   b. A156.3, Exit Devices.
   c. A156.4, Door Controls -Closers.
   d. A156.6, Architectural Door Trim.
   e. A156.8, Door Controls - Overhead Stops and Holders.
   f. A156.13, Mortise Locks.
   g. A156.18, Materials and Finishes.
   h. A156.21, Thresholds.
2. American National Standards Institute/Steel Door Institute (ANSI/SDI).
   a. A250.8, Specifications for Standard Steel Doors and Frames (SDI-100).
3. Door and Hardware Institute (DHI).
4. National Fire Protection Association (NFPA):
   a. NFPA 101, Life Safety Code.

C. Qualifications:

1. Installation shall be inspected by a certified Architectural Hardware Consultant (AHC).

1.3 DEFINITIONS

A. AHC: Architectural Hardware Consultant, certified by DHI.

B. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

C. All weather: Capable of operation from -50 to +120 degrees F.

D. Active Leaf: Right-hand leaf when facing door from keyed side unless noted otherwise on Drawings.

1.4 SUBMITTALS

A. Shop Drawings:

1. Qualifications
   a. AHC qualifications.
2. Certification from AHC stating:
   a. All door hardware has been reviewed by AHC and verified to be compatible with doors and frames.
   b. No submittals will be reviewed until Engineer has received AHC certification.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
4. Schedule of all hardware being used on each door.
   a. Number hardware sets and door references same as those indicated on Drawings.
5. Technical data sheets on each hardware item proposed for use.
6. Warranty information for all hardware devices having extended warranties.

B. Informational Submittals:

1. Certifications:
   a. Certification from AHC stating all door hardware has been provided per approved Shop Drawings, has been installed in accordance with manufacturer's recommended installation instructions and all doors have been inspected and tested and found to be in proper working order.
      1) Door assemblies required to swing in the direction of egress have been inspected and tested in accordance with NFPA 101.

1.5 WARRANTY

A. Provide all individual manufacturers' extended warranties as advertised.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Hinges:
   a. Hager Companies.
   b. McKinney Manufacturing Co.
   c. Stanley by dormakaba Holding, Inc.
2. Locksets and latchsets:
   a. Best Access Solutions, Inc. by dormakaba Holding, Inc.
   b. Corbin Russwin, Inc. by ASSA ABLOY.
3. Exit devices:
   a. Corbin Russwin, Inc. by ASSA ABLOY.
   b. PRECISION by dormakaba Holding, Inc.
   c. SARGENT Manufacturing Company by ASSA ABLOY.
   d. Von Duprin by Allegion PLC.
4. Closers:
   a. Corbin Russwin, Inc. by ASSA ABLOY.
   b. LCN by Allegion PLC.
   c. Norton by ASSA ABLOY.

5. Door stops and holders:
    a. Trimco.
    b. Rockwood by ASSA ABLOY.
    c. IVES by Allegion PLC.
6. Overhead stops:
    a. Glynn-Johnson by Allegion PLC.
    b. Rockwood by ASSA ABLOY.
    c. Trimco.
    d. Rixson by ASSA ABLOY.
7. Weatherstripping and thresholds:
    a. Pemko by ASSA ABLOY.
    b. Reese Enterprises, Inc.
    c. Zero International, Inc.
    d. National Guard Products.
8. Door bolts, coordinators and strikes:
    a. IVES by Allegion PLC.
    b. Trimco.
    c. Hager Companies.
    d. Rockwood by ASSA ABLOY.
    e. dormakaba.
9. Other materials: As noted.

2.2 MATERIALS

A. General: As indicated in the FABRICATION Article in PART 2 of this Specification Section.

B. Fasteners: Stainless steel or aluminum.

C. Closers:
    1. Corrosion resistant closer:
        a. Body: Aluminum.
        b. All other components and fasteners: Stainless steel.
        c. Closer arm bushing: Bronze.

D. Kickplates:
    1. Stainless steel.

E. Thresholds: Aluminum.

F. Overhead Stops and Wall Stops: Stainless steel or aluminum.

G. Keys: Brass or bronze.

H. Weatherstripping and Smoke Seals: Polypropylene, neoprene, or EPDM.

I. Pulls and Push Plates: Stainless steel.

J. Silencers: Rubber.

2.3 COMPONENTS

A. Hinges:
    1. Butt hinges:
        a. ANSI/BHMA A156.1.
            1) A5111: Stainless steel, full-mortise, anti-friction bearing, Grade 1.
        b. Ball bearing.

c. Flat button tips.
d. Butt hinges:
1) Hager BB1199.
2) McKinney T4B3386.
e. Hinge size:
1) Doors up to and including 46 inches wide: 4.5 inches x 4.5 inches.
2) Doors over 46 inches up to and including 60 inches wide: 5 inches high x 4.5 inches.

B. Mortise Locks and Latches:
1. ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 1.
2. Antifriction two-piece mechanical latchbolt with stainless steel anti-friction insert.
a. One-piece stainless steel deadbolt, minimum 1-1/4 inches x 9/ 16 inches thick with 1 inch throw.
b. 2-3/4 inches backset.
c. Cylinder: Brass, 6-pin, with interchangeable core.
3. Locking, latching and retracting mechanism and lock case:
a. Steel, unless noted otherwise.
1) Chrome or zinc dichromate plated.
4. Trim design: Corbin Russwin, Inc. "NSP".
a. Functions as indicated in following table in accordance with ANSI/BHMA A156.13.

MORTISE LOCK NUMBERS		
ANSI	FUNCTION	CORBIN RUSSWIN, INC.
F13	Entrance or Office	ML2065

C. Exit Devices:
1. ANSI/BHMA A156.3, Grade 1.
2. Single doors: Mortise.
3. Pairs of doors: Concealed vertical rods.
4. Trim: Sargent “ET”.
a. Lever operation.
b. Lever style: Sargent "L".
5. Sargent "80 Series".
a. Function as indicated on Hardware Schedule.

D. Door Closers:
1. ANSI/BHMA A156.4, Grade 1.
2. Size door closers to comply with ANSI recommendations for door size and location.
3. Fabricate all closers with integral back check.
4. Provide integral stop unless noted otherwise.
a. Do not provide integral stop at closers indicated to be installed on pull side of door.
b. Provide all weather fluid for all closers used in exterior doors.
5. Full cover.
a. Manufacturer's standard plastic cover.
6. Arms, brackets, and plates: As required for complete installation.
7. Closers:

a. LCN 4040 Series or Norton 7500 Series or Corbin Russwin, Inc. DC6200 Series.

8. Provide manufacturer's standard 10 year warranty.

E. Door Stops:

1. ANSI/BHMA A156.16.
   a. Wall stops: IVES WS406-CVX or WS406-CCV.

F. Overhead Door Holders/Stop:

1. ANSI/BHMA A156.8.
2. Provide 'hold-open' function on all stops unless noted otherwise.
   a. Do not provide ‘hold-open’ function at fire rated doors.
3. Surface mounted stops: Rockwood N14400 Series or Glynn Johnson 90 Series.
4. Concealed stops: Rockwood N11000 Series or Glynn Johnson 100 Series.

G. Kickplates:

1. ANSI/BHMA A156.6.
2. 8 inches high x 2 inches less than door width.
3. Beveled on all edges.
1. Thickness:
   a. Stainless steel: 0.050 inches.

H. Manual Flushbolts (MFB):

1. Include Dustproof Strikes.

I. Dustproof Strikes:

1. Base: Ives DP2.
2. Include with Flushbolts.

J. Door Coordinators:

1. Base: Ives, COR Series.
2. Optional: Door Controls, 600 Series.
3. Provide where indicated.
4. Provide where Astragals are used.
   a. Exceptions:
      1) Coordinators are not required at double egress pairs.
      2) Coordinators are not required where Manual Flushbolts are used.
   b. Provide where Automatic and Constant Latching Flushbolts are used.
5. If coordinator is provided for door which has stop which lacks enough surface area to allow proper mounting, provide mounting accessories.
6. Provide solid shim or other fascia piece that will result in surface being flush with edge of coordinator.
7. Provide filler sections as required to finish opening.

K. Head Drip:

a. Provide on exterior doors other than main entrance doors.
b. Bed flange in sealant and screw to head of frame using non-corrosive fasteners.
c. Base Product: R201 by Reese.

L. Cylinders:

1. ANSI/BHMA A156.5 Grade 1.
2. Material: Brass or bronze, stainless steel, or nickel silver.

3. Finish: Match lock mechanism to which cylinders are installed.

a.

M. Thresholds:

1. ANSI/BHMA A156.21.
2. One-piece unit.
3. Height: 1/2 inches high maximum.
   a. This height is measured from the top of the threshold to the adjacent landings on either side.
4. Width: See drawings.
5. Provide required bolt cutouts.

N. Weatherstripping:

1. Weather seal at jambs and head:
   a. Self-adhesive strip: Reese #797.
   b. Color: Black.
2. Sweep at bottom of doors:
   a. Reese 701.
   b. Color: Clear anodized.
3. Weather seal astragal at meeting edges of pairs of doors:
   a. Reese 92 each leaf.
   b. Color: Clear anodized.

O. Automatic Door Bottom:

1. Provide end caps for semi-mortised and surface mounted units.
2. 3/4 inches drop, neoprene gasket: Reese #521.

2.4 ACCESSORIES

A. Silencers:

1. Hollow metal frames: Trimco 1229A or Rockwood 608.
2. Self-adhesive silencers are not acceptable.

B. Keying:

1. Establish keying with Owner.
   a. Provide and set up complete visible card indexed system with key tags and control slips.
   b. Tag and identify keys.
   c. Provide two keys for each lock or cylinder.
   d. Master key and key in groups as directed.
   e. Provide construction master keys for all exterior doors.

C. Strikes:

1. Curved lips.
   a. Extended lips when required.
2. Furnish strike boxes.
3. Appropriate for function and hardware listed.

2.5 FABRICATION

A. General:

1. Generally prepare for Phillips head machine screw installation.

2. Exposed screws to match hardware finish or, if exposed in surfaces of other work, to match finish of other work as closely as possible.
3. Provide concealed fasteners unless thru bolted.
4. Through bolt closers on all doors.
5. Furnish items of hardware for proper door swing.
6. Furnish lock devices which allow door to be opened from inside room without a key or any special knowledge.

B. Hardware:

1. Fabricate hardware for fire rated openings in compliance with UL and NFPA 80.
   a. This requirement takes precedence over other requirements for such hardware.
   b. Provide only hardware which has been tested and listed by UL for types and sizes of doors.
2. Provide following ANSI/BHMA A156.18 finishes:
   a. Locksets, latchsets and strikes: 630.
   b. Door pulls, push bars, push plates: 630.
   c. Kickplates:
      1) Stainless steel: 630.
   d. Exit devices: 630 where available; 626 if 630 is not available.
      1) Provide 630 finish on trim.
   e. Butt hinges: 630.
   f. Door stops, dead locks, mortise bolts, and miscellaneous hardware: 630 where available, 626 if 630 not available.
   g. Door overhead stops: 630.
   h. Closers: 600 prime coat with 689 finish coat, unless noted otherwise.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's installation instructions.

1. Perform installation by or under the direct supervision of an AHC.

B. Provide all hardware in accordance with the building code.

C. Fit hardware before final door finishing.

D. Permanently install hardware after door finishing operations are complete.

E. Locate hardware in accordance with ANSI/SDI A250.8.

F. Butt Hinges:

1. Provide non-removable pin (NRP) at:
   a. Exterior doors.
   b. Reverse handed doors equipped with locks.
2. Quantities:
   a. Door height 61 - 90 inches: Three.
   b. Door height 91 - 114 inches: Four.
   c. Door height 115 - 144 inches: Five.
   d. Doors over 48 inches wide and over 96 inches high:
      1) Provide top butt hinge within 6 inches of the top of the door to top of hinge.
      2) Provide one additional butt hinge approximately 6 inches below the bottom of the top butt hinge.

3. Provide power transfer as necessary where electrified lockset or exit device is specified or as otherwise indicated in Hardware Schedule.

G. Closers:

1. Mount closers on push side of doors unless noted otherwise.

H. Provide coordinator when required by hardware specified.

I. Astragal:

1. Reese 183 or equal.

J. Wall Mount Door Stops:

1. Provide where specifically indicated on Hardware Schedule and at doors not otherwise indicated to receive:
   a. Overhead stop.
   b. Closer with integral stop.

K. Floor mounted stops are not acceptable unless noted otherwise in this Specification Section.

L. Provide silencers for door frames.

1. Hollow metal frames: See Specification Section 08 11 00.

M. Provide weather seal, door sweep and threshold at all exterior doors and where scheduled on interior doors.

1. Set thresholds in a full bed of sealant.
2. Mount door sweeps on exterior face of door.
3. Mount weather seal astragal at meeting edges of pairs of doors on the exterior face of the doors.

N. Provide smoke seals on all fire rated doors.

O. Mount kickplates on push side of doors.

P. Deliver permanent lockset cores to Owner.

1. Owner will change all cores and return construction cores to Contractor.

Q. Install keyless entry system in accordance with manufacturer's recommendation.

3.2 FIELD QUALITY CONTROL

A. Adjust and check each operating item of hardware to assure proper operation or function.

1. Lubricate moving parts with lubricant recommended by manufacturer.

B. During week prior to startup, make a final check and adjustment of all hardware items.

1. Clean and lubricate as necessary to assure proper function and operation.
2. Adjust door control devices to compensate for operation of heating and ventilating equipment.

C. Inspection and Testing:

1. AHC shall inspect and test all door assemblies and provide written certification that door assemblies are in proper working order.
   a. Door assemblies required to swing in the direction of egress shall be inspected and tested in accordance with NFPA 101.
2. Submit documentation and certification of testing in accordance with the certifications paragraph in the SUBMITTALS Article in PART 1 of this Specification Section.

3.3 SCHEDULES

A. Hardware Schedule:

HW-01
Door 101.1, 101.4, 102.1
Hinges
Closer
Exit Device - Rim
Kickplate
Weatherstripping
Threshold
Automatic door bottom
Head drip.
Stop.

HW-02
Door 101.2, 102.2
Hinges
Mortise lockset - office F04
Kickplate

HW-03
Door A101
Hinges
Closer on active leaf.
Mortise Exit Device active leaf
Cylinder active leaf
Lever trim active leaf

Manual flush bolts – inactive leaf
Dust proof strikes top and bottom – inactive leaf
Curved lip strike at inactive leaf.
Astragal
Weatherstripping
Kickplates
Automatic door bottom
Threshold
Stops
Head drip.

END OF SECTION

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SECTION 08 81 00
GLASS AND GLAZING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Glass and glazing.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 07 92 00 - Joint Sealants.
2. Section 08 11 00 - Hollow Metal Doors and Frames.
3. Section 08 51 13 Aluminum Windows

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI):
   a. Z97.1, Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.
2. ASTM International (ASTM):
   a. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   b. C1036, Standard Specification for Flat Glass.
   c. C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
   d. C1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
   e. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   f. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
3. Code of Federal Regulations (CFR):
   a. Title 16 - Commercial Practices, Chapter ii - Consumer Product Safety Commission (CPSC), Subchapter B - Consumer Product Safety Act Regulations:
      1) 16 CFR 1201, Safety Standard for Architectural Glazing Materials.
4. Glass Association of North America (GANA):
   a. Glazing Manual.
5. Insulating Glass Certification Council (IGCC).
6. Insulating Glass Manufacturers Alliance (IGMA):
   a. TM-3000, North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial & Residential Use.
7. National Fire Protection Association (NFPA).
   a. 80, Standard for Fire Doors and Other Opening Protectives.
   b. 251, Standard Methods of Tests of Fire Resistance of Building Construction and Materials.
   c. 252, Standard Methods of Fire Tests of Door Assemblies.
   d. 257, Standard on Fire Test for Window and Glass Block Assemblies.
8. Underwriters Laboratories, Inc. (UL):
   a. 9, Standard for Fire Tests of Window Assemblies.
   b. 10B, Standard for Fire Tests of Door Assemblies.
   c. 263, Standard for Fire Tests of Building Construction and Materials.

1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

B. Safety Glazing: Glazing meeting the requirements of the building code and CPSC 16 CFR 1201.

C. Other terms as identified in CSPC 16 CFR 1201.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Certification that glass has been tested and approved for use in fire resistance rated doors or walls.
      1) Copies of all test criteria.
2. Certification that insulating glass units meet requirements of IGCC and are certified by IGCC to ASTM E2190.

B. Samples:

1. Two, 6x 6 inches sample of each type, color, and thickness specified.
   a. Samples are not required for clear monolithic glass.

C. Informational Submittals:

1. Warranty.

1.5 WARRANTY

A. Provide manufacturer's written 10 year warranty to cover deterioration of glass, glass units, coatings and ceramic frit.

1. Insulating glass units shall be warranted against failure of hermetic seal resulting in fogging or film formation on the interior glass surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Glass:
   a. Guardian Glass by Guardian Industries.
   b. Insulite Glass Co., Inc.
   c. NSG/Pilkington.
   d. Oldcastle Building Envelope.
   e. Vitro Architectural Glass.
   f. Viracon.
2. Gaskets, glazing compounds, setting blocks, spacers, sealant, sealant tape, etc., as recommended by glass manufacturer, glass unit fabricator.
   a. Provide materials as required by NFPA for use in fire-rated units.

2.2 MATERIALS

A. General:

1. ASTM C1036.
   a. Clear glass: Type II (wired), Class 1, Quality Q3.
2. Thickness: 17/64 inches, unless noted otherwise.

B. Heat Strengthened and Fully Tempered Glass: ASTM C1048.

1. General use: Kind HS.
2. Safety glazing: Kind FT.
   a. Meet requirements of ANSI Z97.1 and CSPC 16 CFR 1201.
3. Condition:
   a. Clear or tinted vision glass: Condition A.
   b. Spandrel Glass (ceramic coated): Condition B.
   c. Coated vision glass: Condition C.
      1) ASTM C1376, Kind CV or CO.

2.3 MANUFACTURED UNITS

2.4 ACCESSORIES

A. Glazing Compounds:

1. Non-sag, non-stain type.
2. Pigmented to match frame units not requiring painting.
3. Compatible with adjacent surfaces.
4. One- or two-part polyurethane or silicone sealant for use in setting glass.
   a. Provide glazing compounds which will not be affected by chemicals stored in rooms where glazing compounds are used.

B. Sealant Tape: Butyl rubber sealant tape or ribbon having a continuous neoprene shim.

C. Gaskets:

1. Flexible polyvinyl chloride or neoprene.
   a. ASTM C864.
   b. Provide gaskets which will not be affected by chemicals stored in rooms where gaskets are used.
2. Extruded of profile and hardness required to receive glass and provide a watertight installation.
3. Provide gaskets in accordance with NFPA in fire resistance rated glazing.

D. Setting Blocks and Spacers:

1. Neoprene or EPDM, compatible with sealants used.
   a. ASTM C864.

E. Compressible Filler Stock: Closed cell polyethylene or polyethylene jacketed polyurethane foam.

F. Shims, Clips, Screws and Other Miscellaneous Items: As required by condition.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with recommendations of manufacturer, GANA Glazing Manual and IGMA TM-3000.

B. Install setting blocks in adhesive or sealant.

C. Install spacers inside and out, of proper size and spacing, for all glass sizes larger than 50 united inches, except where gaskets are used for glazing.

D. Provide 1/8 inches minimum bite of spacers on glass.

E. Spacer thickness to equal sealant width.

F. Prevent sealant exudation from glazing channels of insulating glass which is more than 1/2 inches thick; colored, heat absorbing, coated or laminated glass sizes larger than 75 united inches; and other glass more than 9/32 inches thick or larger than 125 united inches.

1. Leave void at heel (or install filler) at jambs and head.
2. Do not leave void (or install filler) at sill.

G. Miter cut and bond gasket ends together at corners.

H. Immediately after installation, attach crossed streamers to framing held away from glass.

I. Use polysulfide-based glazing sealants in window assembly and as perimeter sealant around frames in areas which may be exposed to chlorine gas or chlorine liquid splash or spillage.

1. See Specification Section 07 92 00 for sealants.

J. Install fire resistance rated glass in accordance with manufacturer's recommendations and in accordance with applicable fire testing criteria.

3.2 FIELD QUALITY CONTROL

A. Do not install glass with edge damage.

B. Do not apply anything to surfaces of glass.

C. Remove and replace damaged glass.

3.3 CLEANING

A. Maintain glass reasonably clean during construction, so that it will not be damaged by corrosive action and will not contribute to deterioration of other materials.

B. Wash and polish glass on both faces not more than seven days prior to acceptance of work in each area.

1. Comply with glass manufacturer's recommendations.

3.4 SCHEDULES

A. General:

1. Provide safety glazing for all applications where required by the building code and CPSC 16 CFR 1201.
2. Provide heat strengthened glazing for all general use applications where safety glazing is not required.

B. Glass Type 1: Clear Monolithic Glass.

END OF SECTION

SECTION 08 90 00
LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Louvers and vents.

B. Related Sections include but are not necessarily limited to:

1. Section 07 62 00 - Flashing and Sheet Metal.
2. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association (AA):
   a. DAF 45, Designation System for Aluminum Finishes.
2. Air Movement and Control Association (AMCA).
3. ASTM International (ASTM):
   a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.3 SUBMITTALS

A. Shop Drawings:

1. Drawing showing location of each louver or vent, indicating size and arrangement of blank-off plates if required.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Color chart showing manufacturer's full line of colors including exotic and special colors for color selection by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Louvers:
   a. Airolite Company LLC.
   b. Construction Specialties, Inc.
   c. Ruskin Company.
   d. Industrial Louvers, Inc.
   e. American Warming and Ventilating.

2.2 MANUFACTURED UNITS

A. Louvers:

1. 6 inches deep.
2. Drainable with blades at 37-1/2 degrees.
3. Continuous blade appearance.

4. ASTM B221 extruded aluminum, alloy 6063T5, minimum 0.081 inches thick.
5. Minimum free area: 57%
6. Maximum pressure drop: 0.10 inches of water at 700 fpm.
7. Water penetration: 0.01 oz/SQFT at 873 fpm.
8. AMCA certified.
9. Ruskin "ELF 6375DX".
10. Insect screen:
    a. 18-16 mesh aluminum.
    b. Install in standard aluminum frame.

B. Anchors, Fasteners, Reinforcing: Aluminum or stainless steel.

C. Finish:
1. Meet requirements of AAMA 2605.
    a. PVDF coating with minimum 70% resin content.
    b. Color: To be selected by Engineer.

D. Size: Refer to Mechanical Drawings for louver size, and refer to Architectural Drawings for louver shapes.
1. Confirm prior to ordering, mechanical drawing dimensions are compatible with architectural drawing dimensions.
    a. Contractor to verify

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install anchoring and bracing accessories as required.

C. Seal around perimeter on exterior and interior.
1. See Section 07 92 00.

D. Install 0.040 inches aluminum flashing at sill to match louver .
1. See Section 07 62 00.

END OF SECTION

DIVISION 09

FINISHES

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SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Non-Structural Metal Framing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 REFERENCES

A. The American Iron and Steel Institute (AISI):

1. AISI S220 North American Standard for Cold-Formed Steel Framing – Nonstructural Members.

B. ASTM International (ASTM):

1. ASTM C635 Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
2. ASTM C645 Standard Specification for Nonstructural Steel Framing Members.
3. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
4. ASTM C754 Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
5. ASTM A1003 Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-Coated for Cold-Formed Framing Members.
6. ASTM A1007 Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories.

C. Gypsum Association (GA):

1. GA-216 Application and Finishing of Gypsum Panel Products.

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer's specifications for each type of material and accessory.
   a. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
2. Where EQ coatings are used, submit copies of nationally recognized testing laboratory results showing conformance with ASTM A653 and AISI S220.
   a. Include data required to show specification compliance.

B. Shop Drawings:

1. Sizes and spacing of typical framing members and opening framing.
2. Show locations and sizes of atypical framing members, wall framing sections, and opening elevations.
3. Methods of fastening framing members to each other and to supporting systems.
4. Details of vertical deflection connections to structures.
5. Locations and spacing of lateral bracing and structural bracing systems.
6. Accessory products required for complete installation.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Member of Certified Steel Stud Association (CSSA), Steel Framing Industry Association (SFIA), or Steel Stud Manufacturers Association (SSMA).

A. Code-Compliance Certification of Studs and Tracks:

1. Provide documentation that framing members are certified according to the product-certification program of CSSA, SFIA or SSMA.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Non-Structural Metal Framing:

1. Base:
   a. ClarkDietrich Building Systems
2. Optional:
   a. CEMCO Steel Framing and Metal Lath
   b. Custom Stud Inc.
   c. Marino/WARE
   d. MBA Metal Framing
   e. MRI Steel Framing LLC
   f. Telling Industries
   g. The Steel Network

B. Flexible Track:

1. Base:
   a. ClarkDietrich Building Systems
2. Optional:
   a. The Steel Network
   b. Flex-Ability Concepts

C. Products proposed for use in fire-rated assemblies:

1. Approved by nationally recognized testing laboratory.

D. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

A. Select steel studs in accordance with manufacturer's standard load tables and following design pressures and maximum deflections:

Performance Criteria		
Use Condition [2]	Design Pressure	Maximum Deflection
Typical Interior Walls/Partitions (those not listed above)	5 psf 240 Pa	L/240

Footnotes

1. Limit deflection to L/360 where wall cladding on either face is any of the following: Ceramic Tile, Stone Tile, Porcelain Tile, Thin Brick, Lath & Plaster, Simulated Masonry, Adhered Stone, Veneer Plaster, and similar brittle finishes which are prone to movement induced cracking.
2. Where elements meet multiple conditions; Use most stringent Deflection and Design Pressure values.

2.3 MATERIALS

A. Metal Studs and Floor Tracks:

1. C-shaped, roll formed studs and tracks conforming to ASTM C645.

2. Steel design standard: 33KSI 227 MPa.
3. Galvanized: G40 or G40EQ conforming to ASTM A653 and AISI S220.
4. Stud and track depths: As indicated by wall type.
5. Minimum flange width: 1-1/4-inch 6 mm.
6. Minimum thickness: 30 mil (20 GA) 0.752, except as follows:
   a. Increase member thickness to comply with performance criteria.
   b. Decrease member thickness to minimum 18 mil (25 GA) 0.46 mm studs at following condition:
      1) Where walls do not extend to overhead structural deck and supporting diagonal bracing or horizontal stiffeners are used.
7. In lieu of increased member thickness, design may employ diagonal braces above ceiling to reduce overall span.
   a. Coordinate locations with building services items.
   b. Do not employ studs with member thickness less than allowed by fire resistance rated assemblies.
8. High strength 50 ksi 345 MPa or 70 ksi 483 MPa studs shall comply with design criteria of equivalent thickness standard 33 ksi 227 MPa studs listed.
9. At walls designated STC 40 and above, use only studs with physical characteristics of studs used in documented STC testing.
10. Base product: ProSTUD Drywall Framing by ClarkDietrich.
11.

B. Flexible Track:
   1. Adjustable segmented track fabricated from same material, gauge, and width as specified for straight track.
   2. Use at curved walls and soffits.
   3. Base product: 360Trak by ClarkDietrich.

C. Head of Wall Accessories:
   1. Configure to accommodate deflection of superstructure without inducing axial loading on partition wall.
   2. Maintain structural integrity, fire and smoke-resistance, and sound control as required by each wall.
   3. Slotted top deflection track:
      a. Deep leg, vertically slotted track.
      b. Cold-formed sheet steel; galvanized; G60.
      c. Thickness: 30 mil (20 GA) 0.752 mm minimum.
      d. Width: As required for stud sizes indicated.
      e. Depth: Minimum 2-1/2-inch 63 mm down-standing legs with 1/4-inch 6 mm wide by 1-1/2-inch 38 mm high slots spaced 1 inch 25 mm on center.
      f. Base product: MaxTrak by ClarkDietrich.
   4. Z-bars, cold formed channels, and clips:
      a. Accommodate thickness of spray-applied fire-resistive materials.
   5. UL-listed fire-resistant components tested for compliance with requirements indicated.

D. Metal Backing:
   1. General:
      a. See Drawings for applications of backing types listed and further details.
      b. Use heavier gauge as necessary for items to be supported.

c. Comply with manufacturer's backing requirements if capacity exceeds types listed.

2. Track Fasteners:
   a. Power driven type, to withstand minimum 190 pounds 86 kg shear when driven.
3. Track and Channel Systems:
   a. ASTM C645 roll-formed steel with G40 galvanized coating.
   b. Thickness: 30 mil (20 GA) 0.752 mm minimum; Use heavier gauge as dictated by conditions.
   c. Carrying channels:
      1) Size: 1-1/2-inch 38 mm.
   d. Furring channels:
      1) Sizes: 7/8-inch and 1-1/2-inch 22 mm x 38 mm, as indicated.
4. Anchors in Concrete:
   a. Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 5 times that imposed by ceiling construction, as determined by testing per ASTM E488 or ASTM E1512 as applicable.
   b. Acceptable types: Cast-in-place, post-installed expansion anchors and post-installed bonded anchors.
   c. Material: Carbon-steel components zinc plated to comply with ASTM-B633, Class Fe/Zn 5 for Class SC 1 service condition.
5. Powder-Actuated Fasteners in Concrete:
   a. Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing per ASTM E1190.
   b. Comply with seismic design requirements where applicable.
6. Other items including suspension wire, tie wire, attachment devices: As specified and indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structure and conditions under which system will be installed.

B. Correct conditions detrimental to proper installation.

C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Layout and install metal framing accurate to dimensions indicated in drawings.

B. Installation Standards:
   1. ASTM C754 and ASTM C1007, except comply with framing sizes and spacing indicated.
   2. Gypsum Board Assemblies: Comply with additional requirements in ASTM C840 and GA-216 relative to framing installation.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, wall stops, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

F. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

G. Extend framing full height to structural supports.

1. Exception: Where partitions are indicated to terminate at, or just above, suspended ceilings.
2. Continue framing around ducts and similar items which penetrate partitions.

H. Position studs vertically engaging floor track and head of wall deflection track.

1. Align stud knockouts to facilitate running of wires and conduit.

I. Space studs maximum 16 inches 400 mm on center.

1. Stud spacing at Shaftwall: 24 inches 610 mm on center.

J. Provide additional studs at corners, partition intersections and terminations of partitions, and at each side of control joints.

K. Positively anchor studs to floor tracks with self-tapping pan head screws, or stud clinching tool per ASTM C754.

L. Anchor studs to deflection track with wafer head screws on both flanges of each stud.

1. Maintain deflection gap between top of stud and top of slotted track.
2. Install screws at centerline of slot and secure allowing vertical movement.

M. Anchor fire rated partitions as required by fire resistance design, and firestopping design.

N. Where partitions abut vertical structural elements, provide perimeter relief per Gypsum Association GA-600 Strain Relief System details.

O. Head-of-Wall:

1. Provide slotted top track for walls extended to structure.
2. Configure to resist lateral loads while accommodating deflection of overhead building superstructure without inducing axial loading on partition framing.
3. Secure deflection track to structure in accordance with industry standards and regulatory requirements.
4. Secure at corners and at ends.
5. Cut vertical studs 5/8-inch 16 mm short to create a deflection gap when installed into top track.
   a. Secure vertical studs to top track with framing screw at each stud, screwing through track slots for positive stud connection.
6. Secure Gypsum Wallboard to vertical studs; do not secure Gypsum Wallboard to top track directly.

P. Furring Channels:

1. Attach furring channel systems directly to parent walls.
2. Install channels at maximum 16 inches 400 mm OC.
3. Provide additional framing at openings, cutouts, corners, and control joints.
4. Space fasteners not more than 24 inches 610 mm OC, staggered on opposite flanges of furring channels.

Q. Sound Isolation Clips:

1. Install per manufacturer’s instructions.
2. Where electrical device, outlet, and service boxes are fastened to framing with Sound Isolation Clips:
   a. Leave a gap between the gypsum wallboard and the electrical device, outlet, or service box to avoid flanking of the Sound Isolation Clips.
   b. Seal the gap with Acoustical Sealant.

R. Stud Wall Isolation Strip:

1. Install per manufacturer's instructions.

3.3 FRAMING AT OPENINGS

A. Control Joints (CJ):

1. Install additional stud, maximum 1/2 inch 13 mm from jamb studs.
2. Do not fasten extra stud to track or jamb stud.
3. Refer to specification Section 09 29 00 for control joint locations.

B. Prefabricated headers, jambs, and sill framing systems option:

1. Proprietary opening framing systems may be used as an alternative to conventionally fabricated framing.
2. Pre-approved Products:
   a. HDS Framing System by ClarkDietrich.
   b. Quick Frame Rough Opening System by Marino/ Ware.

C. Door Openings:

1. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section for cripple studs at head and secure to jamb studs. Screw into web of jamb stud.
2. Unless indicated otherwise, extend jamb studs through suspended ceilings and secure laterally to overhead structure.
3. Jamb Studs:
   a. Minimum thickness of jamb studs: 30 mil (20 GA) 0.752 mm at openings.
   b. Install two studs at each jamb, toe-to-toe unless otherwise indicated.
      1) Securely attach first stud to frame.
      2) Fill cavity between studs with acoustic batt insulation where required by acoustical rating of wall.
      3) Join second stud to first stud on each face with 30 mil (20 GA) 0.752 mm screw attached steel straps at 42 inches 1070 mm on center maximum.
4. Headers:
   a. Openings less than 4 feet 6 inches 1.37 m wide:
      1) Cut-to-length section of floor runner above and below wall openings.
      2) Cut flanges and bend webs at ends.
      3) Overlap and screw attach jamb studs to frames.
   b. Openings over 4 feet 6 inches 1.37 m wide:
      1) Cut-to-length, horizontal box beam studs above and below wall openings.
      2) Design for actual span and loading.
   c. Incorporate miscellaneous steel members, specified in Section 05 50 00, and wood blocking, specified in Section 06 10 00, where indicated.
5. Control Joints at head of jambs:
   a. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch 13 mm clearance from jamb stud to allow for installation of control joint in finished assembly.
   b. Gypsum Wallboard control joints as specified in Section 09 29 00.

D. Other Framed Openings:

1. Frame openings other than door openings the same as required for door openings, unless otherwise indicated.
2. Cripple Studs:
   a. Install cut-to-length intermediate vertical studs above and below openings.
   b. Spacing: As indicated for typical full-length studs.

c. Match stud framing below sills of openings to framing installed above opening.

3. Incorporate miscellaneous steel members, specified in Section 05 50 00, and wood blocking, specified in Section 06 10 00, where indicated.

3.4 WALL BACKING AND BLOCKING

A. Provide in-wall backing reinforcement where following items are mounted to interior walls and interior face of exterior walls:

1. Crash rails, chair rails, wall bumpers, and similar wall protection devices.
2. Wall-mounted door stops.
3. Contractor or Owner furnished equipment indicated to be wall mounted.
4. Toilet accessories that do not include proprietary backing devices.
5. Toilet partitions and lockers.
6. Markerboards, tackboards, and chalkboards.
7. Other wall-mounted items where backing is indicated by details or specification.

B. Metal Wall Backing requirements are described as Accessory Items in Part 2 of this section.

C. Wood Wall Blocking may be used where allowed by Code and Manufacturer of item to be supported. Specified in Section 06 10 00.

D. Verify metal stud framing has been installed to support wall-mounted items specified in Section 05 50 00.

E. Coordinate mounting height, location, and coverage with item to be supported.

F. Determine material width according to item to be supported.

G. Provide in-wall metal wall backing material to interior metal stud walls specified herein.

H. Attachment: Minimum 2 - #10 sheet metal screws at each stud.

END OF SECTION

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SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gypsum board.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 07 92 00 - Joint Sealants.
2. Section 09 22 16 - Non-Structural Metal Framing.
3.
4. Section 09 96 00 High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   b. C475/C475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
   c. C840, Standard Specification for Application and Finishing of Gypsum Board.
   d. C1002, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
   e. C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
   f. C1396/C1396M, Standard Specification for Gypsum Board.
   g. D3273, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
2. Gypsum Association (GA):
   a. GA-214, Recommended Levels of Gypsum Board Finish.
3. Underwriters Laboratories, Inc. (UL):
   a. Building Materials Directory.
   b. Fire Resistance Directory.

1.3 DEFINITIONS

A. Wet Area:

1. Entire interior of pump building.

1.4 SUBMITTALS

A. Shop Drawings:

1. Drawings of unusual conditions.
   a. Control joint layout.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
3. Manufacturer's adhesive, joint treatment compound and tape recommendations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Gypsum board and accessories:
   a. American Gypsum.
   b. Georgia-Pacific Gypsum LLC.
   c. National Gypsum.
   d. USG Corporation.

2.2 MATERIALS

A. General:

1. Provide UL Listed materials in fire-resistant rated construction.
2. Furnish in lengths as long as practicable.

B. Gypsum Board (GB):

1. See Water and Mold Resistant Gypsum Board (WRGB).
   a. Items referenced as Gypsum Board (GB) shall be supplied as Water and Mold Resistant Gypsum Board (WRGB).

C. 1. Water and Mold Resistant Gypsum Board (WRGB):

   a. Water-resistant core and treated paper facers.
      1) Smooth face for finishing similar to standard gypsum board.
   b. Mold-resistant: ASTM D3273.
   c. USG "Sheetrock Mold Tough".

2.3 ACCESSORIES

A. Trim:

1. ASTM C1047.
2. Galvanized: ASTM A653/A653M G-60, unless noted otherwise.
3. Corner bead:
   a. Standard type with perforated flanges.
   b. ClarkDietrich "#103 Deluxe Corner Bead".
4. Casing and trim bead:
   a. ClarkDietrich "#200-A Metal U-Trim.
5. Control and expansion joints:
   a. ClarkDietrich "#093 Zinc Control Joint."

B. Fasteners:

1. Gypsum board:
   a. ASTM C1002.
   b. Self-drilling, corrosion-resistant bugle head screws.
      1) For fastening gypsum board to metal framing: Type S.

C. Adhesive: As recommended by board manufacturer.

D. Joint Tape:

1. ASTM C475/C475M.
2. Recommended by manufacturer for specified board type and location.

E. Joint Treatment Compound:

1. ASTM C475/C475M.
2. Recommended by manufacturer for specified board type and location.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Verify that metal stud framing has been installed plumb, true, and in accordance with the Contract Documents.
2. Prior to application of gypsum board, ensure that all blocking, backing and bracing has been installed as necessary for the support of appurtenant items.
3. Install gypsum board in accordance with ASTM C840.
4. Install board in fire-rated construction in accordance with UL requirements.
   a. Self-adhesive applied fire rated tape is not acceptable for use on board joints in fire rated walls.
   b. Tape all joints using conventional fire rated joint tape and joint treatment compound.
5. Erect all board vertically with edges over supporting members.
   a. See Specification Section 09 22 16 non-structural metal framing.
6. Secure to each support or framing member with screws.
   a. Provide fasteners of sufficient length to penetrate framing member or stud not less than 3/8 inches.
   b.
   c. Apply in multiple layers as required to meet minimum drywall thickness specified.
7. In areas having gypsum board ceilings and walls, install ceiling first.
8. Bring boards into contact, but do not force into place.
9. Fit neatly and carefully.
10. Stagger edge joints on opposite side of a partition so they occur on different framing members.
11. Hold board in firm contact with support while fasteners are being driven.
12. Proceed with attachment from center of board toward ends and edges.
13. Scribe board prior to cutting.
14. Where gypsum board abuts concrete, masonry, metal deck, exterior doors and windows, or other dissimilar material; provide 3/8 inches joint between edge of gypsum board and abutting material.
    a. Provide continuous casing bead trim on edge of board.
    b. Seal joint with sealant and backer rod.
    c. See Specification Section 07 92 00 for sealant.

B. Installation:

1. Set fasteners between 3/8 and 1/2 inches from edges and 2 inches in from board corner.
   a. Space maximum of 12 inches on center at edges and in field of board.
   b. Where board butts at wall/ceiling juncture, hold fasteners back 6 inches from edges.
   c. Space fasteners closer if required by UL.
2. Install fasteners, in gypsum board, so that head rests in a slight dimple without cutting face paper or fracturing core or as recommended by board/panel manufacturer.

C. Control Joints:

1. Install prefabricated control joints to provide following maximum unjointed lengths or areas:

a. Partitions: 30 feet, maximum straight run.

2. Where control or expansion joints occur in fire or sound rated assemblies, install suitable backing material to maintain required rating.
3. Where a partition or ceiling abuts a structural element or dissimilar wall or ceiling, install corner bead, casing bead or other trim as required.

D. Gypsum Board Finishing:

1. Securely attach continuous corner beads to all external corners in accordance with manufacturer's recommendations.
2. Provide the following minimum levels of gypsum board finish in accordance with GA-214.
   a. Areas exposed to view:
      1) Surfaces to receive painted finish: Level #5.
   b. Provide additional coats of joint compound as required to completely conceal joints, fasteners and accessories.
      1) Joint photographing will not be acceptable.
3. Sand each coat to remove excess joint compound.
   a. Avoid roughing paper facing on board.
4. Finish surface shall be smooth and free of tool marks and ridges.
5. Prime gypsum board surfaces in accordance with Specification Section 09 96 00.
   a. After primer has been applied, inspect surfaces and repair and refinish all areas which show defects.
6. Refer to ASTM C840 for additional finishing requirements.

END OF SECTION

SECTION 09 96 00
HIGH PERFORMANCE INDUSTRIAL COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. High performance industrial coatings (HPIC).
2. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
3. Minimum surface preparation requirements.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC).
3. Division 26 - Electrical.
4. Division 40 - Process Interconnections.
5. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. B499, Standard Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals.
   b. D3359, Standard Test Methods for Rating Adhesion by Tape Test.
   c. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   d. D4259, Standard Practice for Abrading Concrete.
   e. D4261, Standard Practice for Surface Cleaning Concrete Masonry Units for Coating.
   f. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   g. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   h. D4414, Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
   i. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
   j. D6132, Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage.
   k. D6677, Standard Test Method for Evaluating Adhesion by Knife.
   l. D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
   m. D7234, Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
   n. E337, Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
   o. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   p. F2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

2. Environmental Protection Agency (EPA).
3. International Concrete Repair Institute (ICRI):
   a. 310.2, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
4. NACE International (NACE).
5. National Association of Pipe Fabricators (NAPF):
   a. 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings:
      1) 500-03-04, Abrasive Blast Cleaning for Ductile Iron Pipe.
      2) 500-03-05, Abrasive Blast Cleaning for Cast Ductile Iron Fittings.
6. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. SP 1, Solvent Cleaning.
   c. SP 2, Hand Tool Cleaning.
   d. SP 3, Power Tool Cleaning.
   e. SP 16, Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
7. The Society for Protective Coatings/ NACE International (SSPC/ NACE):
   a. SP 5/ NACE No. 1, White Metal Blast Cleaning
   b. SP 6/ NACE No. 3, Commercial Blast Cleaning.
   c. SP 7/ NACE No. 4, Brush-off Blast Cleaning.
   d. SP 10/ NACE No. 2, Near-White Blast Cleaning.
   e. SP 13/ NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Coating manufacturer's technical representative shall be a NACE Certified Coatings Inspector, Level 3 minimum.
   2. Applicators shall have minimum of 10 years of experience in application of similar products on similar project.
      a. Provide references for minimum of three different projects completed in last five years with similar scope of work.
      b. Include name and address of project, size of project in value (coating) and contact person.
   3. NACE inspector shall be NACE Certified Coatings Inspector Level 3 minimum and shall have minimum of five years of experience of conducting inspections and tests as indicated in this Specification Section.

C. Miscellaneous:
   1. Furnish coating through one manufacturer unless noted otherwise.

D. Deviation from specified MIL thickness or product type is not allowed without written authorization of Engineer.

E. Material shall not be thinned unless approved, in writing, by coating manufacturer's technical representative.

1.3 DEFINITIONS

A. Applicator:
   1. Applicator is the person actually installing or applying the product in the field, at the Project site, or at an approved shop facility.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified or in Specification Section 01 61 03.

C. Appurtenant Surface: Accessory or auxiliary surface attached to or adjacent to a surface indicated to be coated.

D. Corrosive Environment:

1. Immersion in or subject to:
   a. Condensation, spillage or splash of a corrosive material such as water, wastewater or chemical solution.
   b. Exposure to corrosive caustic or acidic agent, chemicals, chemical fumes, chemical mixture, or solutions.
   c. For purposes of this Specification Section, corrosive environments include:
      1) Outdoor areas not otherwise identified as highly corrosive.
      2) All interior areas within the Pump Building and Valve Vault.

E. Outdoor Atmosphere or Surface: Outdoor atmosphere or surface exposed to weather and/or direct sunlight.

F. Finished Area: A room or area that is listed in or has finish called for on Room Finish Schedule or is indicated on Drawings to be coated.

G. Holiday:

1. A void, crack, thin spot, foreign inclusion, or contamination in the coating that significantly lowers the dielectric strength of the coating.
2. May also be identified as a discontinuity or pinhole.

H. HPIC: High performance industrial coatings.

1. Epoxies, urethanes, vinyl ester, waterborne vinyl acrylic emulsions, acrylates, silicones, alkyds, acrylic emulsions and any other coating listed as a HPIC.

I. Indoor Atmosphere or Surface: Indoor atmosphere or surface not exposed to weather and/or direct sunlight.

J. Immersion Service:

1. Any surface immersed in water or some other liquid.
2. Surface of any pipe, valve, or any other component of the piping system subject to frequent wetting.
3. Surfaces within two feet above high water level in water bearing structures.

K. Piping System: Pipe, valves, fittings and accessories.

L. Surface Hidden from View:

1. Within pipe chases.
2. Between top side of ceilings and underside of floor or roof structures above.

1.4 SUBMITTALS

A. Certifications:

1. Applicator experience qualifications.
   a. No submittal information will be reviewed until Engineer has received and approved applicator qualifications.
2. NACE inspector certification.
3. NACE inspector experience qualifications.
4. Certification that High Performance Coating Systems proposed for use have been reviewed and approved by a NACE Certified Coatings Inspector employed by the coating manufacturer.

a. Submittals not including this certification will be returned without review.

B. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's surface preparation instructions.
   c. Manufacturer's application instructions.
      1) Manufacturer's standard details, including but not limited to penetrations, transitions, and terminations for:
         a) High-build coatings on concrete.
         b) Secondary containment coatings.
         c) Other special conditions as applicable.
   d. If products being used are manufactured by Company other than listed in the MATERIALS Article of this Specification Section, provide complete individual data sheet comparison of proposed products with specified products including:
      1) Application procedure.
      2) Coverage rates.
      3) Certification that product is designed for intended use and is equal or superior to specified product.
   e. Contractor's written plan of action for containing airborne particles created by blasting operation and location of disposal of spent contaminated blasting media.
   f. Coating manufacturer's recommendation on abrasive blasting.
   g. Coating manufacturer's technical representative's written statement attesting that applicator has been instructed on proper preparation, mixing and application procedures for coatings specified.
   h. Manufacturer's recommendation for universal barrier coat.
   i. Manufacturer's recommendation for providing temporary or supplemental heat or dehumidification or other environmental control measures.
2. Manufacturer's statement regarding applicator instruction on product use.

C. Samples:

1. Manufacturer's full line of colors for Engineer's preliminary color selection.
2. After preliminary color selection by Engineer provide two, 3 x 5 inches samples of each final color selected.

D. Informational Submittals:

1. Approval of application equipment.
2. Applicator's daily records:
   a. Submit daily records at end of each week in which coating work is performed unless requested otherwise by Engineer's on-site representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:

1. Name or type number of material.
2. Manufacturer's name and item stock number.
3. Contents, by volume, of major constituents.
4. Warning labels.
5. VOC content.

B. Store materials in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 degrees F.

1.6 PROJECT CONDITIONS

A. Pre-application Conference:

1. Prior to commencement of surface preparation or coating application, the Contractor shall convene a pre-application conference with all affected parties, including but not limited to: the applicator, coating manufacturer's technical representative, Owner's representative, and Engineer's representative(s).
2. The meeting shall discuss all aspects of the Project including but not limited to:
   a. Schedule.
   b. Material storage and handling.
   c. Examination of surfaces to be coated.
   d. Protection of surfaces not to be coated.
   e. Surface preparation.
   f. Coating application:
      1) Environmental conditions for application of coatings.
      2) Temporary environmental controls.
   g. Field quality control requirements:
      1) Manufacturer's technical representative responsibilities.
      2) Contractor performed testing.
         a) Instrumentation requirements.
         b) Frequency of testing.
         c) Record keeping.
      3) NACE inspector performed testing.

B. Verify that atmosphere in area where coating is to take place is within coating manufacturer's acceptable temperature, humidity and sun exposure limits.

1. Provide temporary heating, shade and/or dehumidification as required to bring area within acceptable limits.
   a. Provide temporary dehumidification equipment properly sized to maintain humidity levels required by coating manufacturer.
   b. Provide clean heat with heat exchanger type equipment sufficient in size to maintain temperature on a 24 hour basis.
      1) Vent exhaust gases to outdoor environment.
      2) No exhaust gases shall be allowed to vent into the space being coated or any adjacent space.
2. Do not apply coatings in snow, rain, fog or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. High Performance Industrial Coatings:
   a. Carboline Protective Coatings.
   b. PPG.
   c. The Sherwin-Williams Company.
   d. Tnemec.

B. "Or-Equal" Submittals:

1. Materials by other manufacturers are acceptable provided that they are established as being compatible with and of equal quality to the coatings of the manufacturers listed.

2. Provide satisfactory documentation from the proposed "or-equal" manufacturer that proposed materials meets or exceeds the following:
   a. Is of the same generic resin.
   b. Requires comparable surface preparation.
   c. Has comparable application requirements.
   d. Meets the same VOC levels or better.
   e. Provides the same finish and color options.
   f. Is suitable for the intended service.
   g. Resistance to abrasion and physical damage.
   h. Resistance to chemical attack.
   i. Resistance to UV exposure.
   j. Ability to recoat in future.
   k. Dry film thickness per coat.
      1) Where manufacturer’s product data sheet indicates a minimum MIL thickness per coat that is greater than specified herein, MIL thickness for entire coating system shall be increased proportionately.
   l. Minimum and Maximum time between coats.
   m. Compatibility with other coatings.
   n. Temperature limitations in service and during application.
   o. Type and quality of recommended undercoats and topcoats.
   p. Ease of application.
   q. Ease of repairing damaged areas.
   r. Stability of colors.
3. The cost of all testing and analyzing of the proposed substitute materials shall be borne by the CONTRACTOR.

2.2 MATERIALS

A. Coatings used for indoor finishes shall meet the requirements of the building code.

   a.

B. Coatings shall comply with the VOC limits of EPA:

C. For unspecified materials such as thinner, provide manufacturer's recommended products.

D. High Performance Industrial Coatings:

COATING CODE	GENERIC DESCRIPTION	MANUFACTURER	
		TNEMEC	SHERWIN WILLIAMS
AAE	Acrylic/Acrylate Emulsion	Series 180 WB Tneme-Crete	Cement Plex 875
AREC	Abrasion-Resistant Epoxy Coating	Series 435 Perma-Glaze	Duraplate 5900
AAP	Aliphatic Acrylic Polyurethane	Series 1095 Endurashield	Acrolon Ultra
AP	Acrylic Polymer	Series 1029 Enduratone	Pro Industrial Acrylic Coating
CRM	Cementitious Repair Mortar	Series 217 MortarCrete	Cemtec Silatec MSM
CRU	Corrosion Resistant Urethane	Series 290 CRU	Polylon HP

COATING CODE	GENERIC DESCRIPTION	MANUFACTURER	
		TNEMEC	SHERWIN WILLIAMS
DFA	Dry-fall Acrylic	Series 115 Uni-Bond DF	DFA Dry Fall Acrylic
EBF	Epoxy Block Filler	Series 1254 Epoxoblock WB	Kem Cati Coat HS
ESF	Epoxy Surfacer/Filler	Series 215 Surfacing Epoxy	Steel Seam FT 910
EMM	Epoxy Modified Cementitious Mortar	Series 218 MortarClad	Duraplate 2300
EF	Epoxy Flooring	Series 237 Power-Tread	GP3746
GFRE	Glass Flake Reinforced Epoxy	Series 142	Sher-Glass FF
HRE	H2S-Resistant Epoxy	Series 132 Protuff Mastic	Duraplate 235
HREM	H2S-Resistant Epoxy Mortar	Series 434 Perma-Shield H_2S	Duraplate 5900 Mortar
MIO	MIO Polyurethane	Series 1 Omnithane	Corothane 1 milesO
MPE	Multi-Purpose Epoxy	Series N69 Hi-Build Epoxoline II	Macropoxy 646
MTEP	Moisture-Tolerant Epoxy Primer	Series 201 Epoxoprime	Corobond 100
PVA	PVA Drywall Primer	Series 51 PVA Sealer	ProMar 200 Zero VOC Interior Latex Primer
SCN	Secondary Containment Novolac	Series 282	Cor Cote HCR
SCE	Secondary Containment Epoxy	Series 237SC Chembloc	Cor Cote HP
SCEP	Secondary Containment Epoxy Primer	Series 206SC Chembloc	GP3552
STEP	Surface-Tolerant Epoxy Primer	Series 135 Chembuild	Macropoxy 646
UHSE	Ultra-High Solids Epoxy (NSF 61)	Series 22 Epoxoline	Duraplate UHS
VEP	Vinyl Ester Primer	Series 251SC Chembloc	Corobond Vinyl Ester Primer
VESC	Vinyl Ester Secondary Containment	Series 252SC Chembloc	Cor Cote VEN FF
PVA	PVA Drywall Primer	Series 51 PVA Sealer	ProMar 200 Zero VOC Interior Latex Primer
SCN	Secondary Containment Novolac	Series 282	Cor Cote HCR
ZRU	Zinc-Rich Urethane	Series 94-H_20 Hydro-Zinc	Corothane 1 Galvapak

2.3 COATING SYSTEMS:

A. The following tables indicate coating systems by material and environment unless a specific application is indicated.

B. Ferrous Metals (Structural and Miscellaneous Metals):

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Indoor atmospheric	SSPC-SP 6/ NACE No. 3	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Indoor atmospheric (corrosive environment)	SSPC-SP 10/ NACE No. 2, min. 2 mil anchor profile	2.5 to 3.5 mil ZRU	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Immersion - non NSF	SSPC-SP 10/ NACE No. 2	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Immersion - NSF	SSPC-SP / NACE No.1	4.0 to 5.0 mil NSFE	4.0 to 5.0 mil NSFE	4.0 to 5.0 mil NSFE
Outdoor atmospheric	SSPC-SP 6/ NACE No. 3	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	2.5 to 3.5 mil AAP

C. Galvanized Steel:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Indoor atmospheric	SSPC-SP 16	4.0 to 6.0 mil STEP		2.0 to 3.0 mil MPE
Immersion - non NSF	SSPC-SP 16	4.0 to 6.0 mil STEP	2.0 to 3.0 mil MPE	2.0 to 3.0 mil MPE
Immersion - NSF	SSPC-SP 16	3.0 to 4.0 mil NSFE		3.0 to 4.0 mil NSFE
Bar Joists (corrosive environment)	SSPC-SP 16	2.5 to 3.5 mil MIO		3.0 to 4.0 mil MPE
Metal Deck (corrosive environment)	SSPC-SP 16	4.0 to 6.0 mil STEP		2.0 to 3.0 mil MPE
Outdoor atmospheric	SSPC-SP 16	4.0 to 6.0 mil STEP		2.5 to 3.5 mil AAP
Field cut pipe threads	SSPC-SP 3	4.0 to 6.0 mil STEP	Coat per exposure above	Coat per exposure above

D. Non Ferrous Metals, including piping:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Dissimilar Materials Protection	SSPC-SP 2	4.5 to 5.5 mil MPE		
Indoor atmospheric	SSPC-SP 2	3.0 to 4.0 mil MPE		3.0 to 4.0 mil MPE
Immersion - non NSF	SSPC-SP 16	3.0 to 4.0 mil MPE		5.0 to 6.0 mil MPE

Immersion - NSF	SSPC-SP 16	4.0 to 5.0 mil NSFE	4.0 to 5.0 mil NSFE	4.0 to 5.0 mil NSFE
Outdoor atmospheric	SSPC-SP 2	4.0 to 6.0 mil MPE		2.5 to 3.5 mil AAP

E. Ferrous Piping:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Indoor atmospheric	SSPC-SP 6/ NACE No. 3	2.5 to 3.5 mil ZRU	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Immersion - non NSF	SSPC-SP 5/ NACE No.1	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Immersion - NSF	SSPC-SP 5/ NACE No.1	4.0 to 5.0 mil MPE	4.0 to 5.0 mil MPE	4.0 to 5.0 mil MPE
Outdoor atmospheric	SSPC-SP 10/ NACE No. 2	2.5 to 3.5 mil ZRU	4.0 to 6.0 mil MPE	2.5 to 3.5 mil AAP
Outdoor atmospheric	SSPC-SP 10/ NACE No. 2	2.5 to 3.5 mil ZRU	3.0 to 4.0 mil MPE	2.5 to 3.5 mil AAP

F. Ductile Iron Piping:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Indoor atmospheric	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Immersion - non NSF	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE
Immersion - NSF	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil NSFE		20.0 to 25.0 mil UHSE
Outdoor atmospheric	Pipe: NAPF 500-03-04 Fittings: NAPF 500-03-05	3.0 to 4.0 mil MPE	3.0 to 4.0 mil MPE	2.5 to 3.5 mil AAP

G. Cast Iron Piping:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Indoor atmospheric	SSPC-SP 1	4.0 to 6.0 mil STEP	2.0 to 3.0 mil MPE	2.0 to 3.0 mil MPE

Outdoor atmospheric	SSPC-SP 1	4.0 to 6.0 mil STEP	2.0 to 3.0 mil MPE	2.5 to 3.5 mil AAP

H. PVC Piping:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Indoor atmospheric	Hand Sanding/ SSPC-SP 1	3.0 to 4.0 mil MPE		3.0 to 4.0 mil MPE
Outdoor atmospheric	Hand Sanding/ SSPC-SP 1	3.0 to 4.0 mil MPE		2.5 to 3.5 mil AAP

I. Concrete:

1. For repair of deteriorated existing concrete, provide additional surface preparation as specified in PREPARATION article in this Specification Section.

Environment/ Application	Surface Preparation	Filler/Surfacer	Prime Coat	Intermediate Coat(s)	Finish Coat
Walls, ceilings, and appurtenant surfaces Indoor atmospheric	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF and/or EMM as necessary to fill holes and depressions	100 to 150 square feet/GAL MPE		100 to 150 square feet/GAL MPE
Indoor floors	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF as necessary to fill holes and depressions	175 to 225 square feet/GAL EF clear	200 to 250 square feet/GAL EF pigmented	200 to 250 square feet/GAL EF pigmented
			broadcast slip-resistant aggregate into wet intermediate coat on walking surfaces		
Indoor Safety Striping	SSPC-SP 13/ NACE No. 6 ICRI CSP 3	ESF and/or EMM as necessary to fill holes and depressions			6.0 to 8.0 mil EF Pigmented
Indoor Secondary Containment	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF and/or EMM as necessary to fill holes and depressions	Horizontal Surfaces		
			6.0 to 8.0 mil MTEP	10 to 12 mil SCN with slip-resistant aggregate broadcast to refusal	10 to 12 mil SCN
			Vertical Surfaces		
			6.0 to 8.0 mil MTEP	6.0 to 8.0 mil SCN	6.0 to 8.0 mil SCN

Environment/ Application	Surface Preparation	Filler/Surfacer	Prime Coat	Intermediate Coat(s)	Finish Coat
Indoor - Secondary Containment Corrosive	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF and/or EMM as necessary to fill holes and depressions	6.0 to 8.0 mil MTEP	60 to 80 mil SCEP Fiberglass mat Saturated with 8.0 to 12 mils SCE	10 to 12 mil SCE
Immersion - non NSF	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	1/16 to 1/4 inches EMM			16 to 20 mil UHSE
Immersion - NSF	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	1/16 to 1/ 4 inches EMM			16 to 20 mil UHSE
Outdoor atmospheric Corrosive Environment	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF and/or EMM as necessary to fill holes and depressions	150 to 175 square feet/GAL AAE		150 to 175 square feet/GAL AAE
Indoor Secondary Containment Non-Corrosive	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF and/or EMM as necessary to fill holes and depressions	Horizontal Surfaces		
			6.0 to 8.0 mil MTEP	10 to 12 mil SCN	10 to 12 mil SCN
			Vertical Surfaces		
			6.0 to 8.0 mil MTEP	2 coats 6.0 to 8.0 mil SCN	2.0 to 3.0 mil CRU
Outdoor - Secondary Containment Corrosive	SSPC-SP 13/ NACE No. 6 ICRI CSP 5	ESF and/or EMM as necessary to fill holes and depressions	6.0 to 8.0 mil MTEP	60 to 80 mil SCEP Fiberglass mat Saturated with 8.0 to 12 mils SCE	10 to 12 mil SCE 20. to 3.0 mil CRU

J. Concrete Masonry:

1. Coverage rates indicated are based on smooth-face normal weight CMU.
2. Provide increased coverage rates in accordance with manufacturer's recommendations for more porous surfaces.

Environment/ Application	Surface Preparation	Filler/Surfacer	Prime Coat	Intermediate Coat(s)	Finish Coat
Indoor atmospheric	Refer to PART 3	100 to 150 square feet/Gal EBF	75 to 100 square feet/Gal MPE		75 to 100 square feet/Gal MPE
Outdoor atmospheric Corrosive Environment	Refer to PART 3	100 to 150 square feet/Gal EBF	175 to 200 square feet/Gal MPE		275 to 300 square feet/Gal AAP
Outdoor atmospheric Non-Corrosive Environment	Refer to Outdoor atmospheric Corrosive Environment.				

K. Gypsum Board:

Environment/ Application	Surface Preparation	Prime Coat	Intermediate Coats	Finish Coat
Paper-faced gypsum board walls, and appurtenant surfaces	Refer to Section 09 29 00	350 to 400 SF/GAL PVA	250 to 300 SF/GAL AP	250 to 300 SF/GAL AP

PART 3 - EXECUTION

3.1 ITEMS TO BE COATED

A. Outdoor Surfaces, including but not limited to:

1. Concrete:
   a. Secondary containment enclosures.
   b. Chemical fill stations.
      1) Paving where indicated on Drawings.
      2) Spill containment sumps.
2. Concrete masonry:
   a. Where indicated on Drawings.
3. Piping, valves, fittings, hydrants and supports:
   a. As scheduled in Specification Section 40 05 00.
4. Pumps and motors.
5. Ferrous metal process equipment.
   a. Equipment bridges.
   b. Gates and operators.
6. Structural steel:
   a. Columns, beams and bracing.
   b. Field welded connections of factory coated structural steel.
7. Miscellaneous ferrous metal surfaces:
   a. Items specifically noted on Drawings to be coated.
8. Miscellaneous galvanized steel surfaces:
   a. Pipe Bollards.
   b. Embed Plates.
   c. Loose lintels.
   d. Steel components of concrete lintels.
   e. Items specifically noted on Drawings to be coated.
9. Appurtenant surfaces attached to or adjacent to a surface indicated to be coated:
   a. Conduit, boxes, covers and supports.

B. Indoor Areas:

1. Refer to Room Finish Schedule on Drawings.
   a. If space is scheduled to be coated, coat all appurtenant surfaces within the space unless specifically noted otherwise. Appurtenant surfaces include but are not limited to:
      1) Columns.
      2) Equipment pads.

3) Equipment supports.
4) Underside of roof or floor decks above:
a) Including semi-exposed or concealed from view unless noted otherwise.
5) Conduit, boxes, covers and supports.
6) Miscellaneous ferrous metal surfaces.

2. Concrete:
a. Chemical storage areas:
1) Flooring where scheduled or indicated on Drawings.
2) Secondary containment enclosures.

3. Piping, valves, fittings, hydrants and supports:
a. Do not coat piping scheduled to be insulated.

4. Pumps and motors.

5. Ferrous metal tankage.

6. Ferrous metal process equipment.
a. Clarifier mechanisms.
b. Equipment bridges.
c. Gates and operators.
d. Items specifically noted on Drawings to be coated.

7. Miscellaneous galvanized steel surfaces:
a. Pipe Bollards.
b. Embed Plates.
c. Loose lintels.
d. Steel components of concrete lintels.
e. Seismic angles at masonry partitions.
f. Items specifically noted on Drawings to be coated.

8. Doors and frames:
a. Hollow metal doors and frames
b. Hollow metal opening frames.

9. Safety Striping:
a. Equipment Pads: Coat vertical face and return 3 inches onto horizontal surface of pad.
b. As shown on Drawings.

3.2 ITEMS NOT TO BE COATED

A. General: Do not coat items listed in this Article, unless noted otherwise.

B. Items with Approved Factory Finish: These items may require repair of damaged coated areas or coating of welded connections.

C. Electrical Equipment.

D. Moving parts of mechanical and electrical units where coating would interfere with the operation of the unit.

E. Code labels, equipment identification or rating plates and similar labels, tagging and identification.

F. Contact surfaces of friction-type structural connections.

G. Stainless Steel Surfaces, except:
1. Dissimilar metals in immersion service.
2. Piping where specifically noted to be coated.
3. Banding as required to identify piping.

H. Aluminum Surfaces, except:
   1. Where specifically shown in the Contract Documents.
   2. Where in contact with concrete.
   3. Where in contact with dissimilar metals.
   4. Appurtenant surfaces as described in the ITEMS TO BE COATED article.

I. Fiberglass Surfaces, except:
   1. Fiberglass piping where specifically noted to be coated.
   2. Piping supports where specifically noted to be coated.
   3. Appurtenant surfaces as described in the ITEMS TO BE COATED article.

J. Mechanical piping scheduled to be insulated.

K. Interior of Pipe, Ductwork, and Conduits.
   1. See Division 23 for ductwork.
   2. See Division 40 for pipe linings.

L. Galvanized Steel Items, unless specifically noted to be coated.

M. Architectural Finishes:
   1. Outdoor concrete indicated to receive another finish.
   2. Precast concrete surfaces, unless specifically indicated to be coated.
   3. Prefinished masonry surfaces:
      a. Pre-colored masonry (outdoor face).
         1) Interior face shall be coated where scheduled.
      b. Prefaced masonry.
   4. Plastic laminate.
   5. Solid surface material.
   6. Standing and running trim.
   7. Fiberglass fabrications.
   8. Anodized aluminum.
   9. PVDF coated metals.
   10. Factory finished doors and frames.
   11. Aluminum windows, curtainwall and storefront framing systems.
   12. Finish hardware.
   13. Glass and glazing.
   14. Ceramic, porcelain, quarry tile or natural stone.
   15. Acoustical materials.
   16. Building specialties.
   17. Louvers.
   18. Casework and countertops.
   19. Pipe insulation and jacketing.
   20. Standing seam metal roof, fascia, trim, soffit and accessories.

3.3 EXAMINATION

A. Concrete:
   1. Test pH of surface to be coated in accordance with ASTM D4262.
      a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable range.

b. Retest pH until acceptable results are obtained.

2. Verify that moisture content of surface to be coated is within coating manufacturer's recommended acceptable limits.
   a. Test surface to be coated in accordance with ASTM D4263 to determine the presence of moisture.
      1) If moisture is detected, test moisture content of surface to be coated in accordance with ASTM F1869 or ASTM F2170.
      2) Provide remedial measures as necessary to bring moisture content within coating manufacturer’s recommended acceptable limits.
      3) Retest surface until acceptable results are obtained.

B. Concrete Unit Masonry:
   1. Test pH of surface to be coated in accordance with ASTM D4262.
      a. If surface pH is not within coating manufacturer's required acceptable range, use methods acceptable to coating manufacturer as required to bring pH within acceptable limits.
      b. Retest pH until acceptable results are obtained.
   2. Verify that moisture content of surface to be coated is within coating manufacturer's recommended acceptable limits.
      a. Test surface to be coated in accordance with ASTM D4263 to determine the presence of moisture.
         1) If moisture is detected, test moisture content of surface to be coated in accordance with ASTM F1869.
         2) Provide remedial measures as necessary to bring moisture content within coating manufacturer’s recommended acceptable limits.
         3) Retest surface until acceptable results are obtained.

3.4 PREPARATION

A. General:
   1. Prepare surfaces to be coated in accordance with coating manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
      a. Where discrepancy between coating manufacturer's instructions and this Specification Section exists, the more stringent surface preparation shall be provided unless approved otherwise, in writing, by the Engineer.
   2. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of coating to surface.
   3. Adhere to manufacturer's recoat time surface preparation requirements.
      a. Surfaces that have exceeded coating manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional coating in accordance with manufacturer's published recommendations.
         1) Minimum SSPC-SP 7/ NACE No. 4 unless otherwise approved by Engineer.

B. Protection:
   1. Protect surrounding surfaces not to be coated.
   2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
   3. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and coat before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:

1. Prepare ductile iron pipe in accordance with pipe manufacturer's recommendations and NAPF.
    a. All piping, pumps, valves, fittings and any other component used in the water piping system that requires preparation for coating shall be prepared in accordance with requirements for immersion service.
    b. Prepare all areas requiring patch coating in accordance with recommendations of manufacturer and NAPF.
    c. Remove bituminous coating per piping manufacturer, coating manufacturer and NAPF recommendations.
        1) The most stringent recommendations shall apply.
2. Complete fabrication, welding or burning before beginning surface preparation.
    a. Chip or grind off flux, spatter, slag or other laminations left from welding.
    b. Remove mill scale.
    c. Grind smooth rough welds and other sharp projections.
3. Solvent clean in accordance with SSPC-SP 1.
4. Restore surface of field welds and adjacent areas to original surface preparation.

E. Galvanized Steel and Non-ferrous Metals:
1. Solvent clean in accordance with SSPC-SP 1 followed by brush-off blast clean in accordance with SSPC-SP 16 to remove zinc oxide and other foreign contaminants.
    a. Provide uniform 1 mil profile surface.

F. Concrete:
1. Cure for minimum of 28 days.
2. Concrete surfaces shall be cleaned in accordance with ASTM D4258.
3. Abrasive blast concrete surfaces in accordance with ASTM D4259 and SSPC-SP 13/ NACE No. 6.
    a. Provide profile per ICRI 301.2 as listed in MATERIALS article of this Specification Section.
4. Test pH and moisture content in accordance with EXAMINATION article in this Specification Section.

G. Concrete Masonry:
1. Cure for minimum of 28 days.
2. Remove all mortar spatters and protrusions.
3. Clean concrete masonry in accordance with Specification ASTM D4261.
4. Test pH and moisture content in accordance with EXAMINATION article in this Specification Section.

H. Preparation by Abrasive Blasting:
1. Schedule the abrasive blasting operation so blasted surfaces will not be wet after blasting and before coating.
2. Provide compressed air for blasting that is free of water and oil.
    a. Provide accessible separators and traps.
3. Protect nameplates, valve stems, rotating equipment, motors and other items that may be damaged from blasting.
4. All abrasive-blasted ferrous metal surfaces shall be inspected immediately prior to application of coatings.
    a. Inspection shall be performed to determine cleanliness and profile depth of blasted surfaces and to certify that surface has been prepared in accordance with these Specifications.

5. Perform additional blasting and cleaning as required to achieve surface preparation required.
    a. Re-blast surfaces not meeting requirements of these Specifications.
    b. Prior to coating, re-blast surfaces allowed to set overnight and surfaces that show rust bloom.
    c. Surfaces allowed to set overnight or surfaces which show rust bloom prior to coating shall be re-inspected prior to coating application.
6. Profile depth of blasted surface: Not less than 1 mil or greater than 2 mils unless required otherwise by coating manufacturer.
7. Ensure abrasive blasting operation does not result in embedment of abrasive particles in coating.
8. Confine blast abrasives to area being blasted.
    a. Provide shields of polyethylene sheeting or other such barriers to confine blast material.
    b. Plug pipes, holes, or openings before blasting and keep plugged until blast operation is complete and residue is removed.
9. Abrasive blasting media may be recovered, cleaned and reused providing Contractor submits, for Engineer's review, a comprehensive recovery plan outlining all procedures and equipment proposed in reclamation process.
10. Properly dispose of blasting material contaminated with debris from blasting operation.

I. All Plastic Surfaces:

1. Sand using 80-100 grit sandpaper to scarify surfaces.

3.5 APPLICATION

A. General:

1. Thin, mix and apply coatings by brush, roller, or spray in accordance with manufacturer's installation instructions.
    a. Application equipment must be inspected and approved in writing by coating manufacturer.
2. Temperature and weather conditions:
    a. Do not coat surfaces when surface temperature is below 50 degrees F unless product has been formulated specifically for low temperature application and application is approved in writing by Engineer and coating manufacturer's technical representative.
    b. Avoid coating surfaces exposed to hot sun.
    c. Do not coat damp surfaces.
    d. Apply coating to concrete or masonry surfaces in descending temperatures, in accordance with coating manufacturer's application instructions.
3. Apply materials under adequate illumination.
4. Provide complete coverage to MIL thickness specified.
    a. Thickness specified is dry MIL thickness.
5. Evenly spread to provide full, smooth coverage.
    a. All coating systems are "to cover."
        1) In situations of discrepancy between manufacturer's square footage coverage rates and MIL thickness, MIL thickness requirements govern.
    b. When color or undercoats show through, apply additional coats until coating is of uniform finish and color.
    c. Finished coating system shall be uniform and without voids, bugholes, holidays, laps, brush marks, roller marks, runs, sags or other imperfections.
6. If so directed by Engineer, do not apply consecutive coats until Engineer has had an opportunity to observe and approve previous coats.

7. Work each application of material into corners, crevices, joints, and other difficult to work areas.
8. Provide coating manufacturer’s recommended details at all terminations, penetrations, embedments, cracks, joints and changes in substrate direction.
9. Avoid degradation and contamination of blasted surfaces and avoid inter-coat contamination.
    a. Clean contaminated surfaces before applying next coat.
    b. Intercoat surface cleanliness shall be inspected and approved by the Engineer prior to application of each coat.
10. Smooth out runs or sags immediately, or remove and recoat entire surface.
11. Allow preceding coats to dry before recoating.
    a. Recoat within time limits specified by coating manufacturer.
    b. If recoat time limits have expired re-prepare surface in accordance with coating manufacturer's printed recommendations.
12. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
13. Coat all aluminum in contact with dissimilar materials.
14. When coating rough surfaces which cannot be backrolled sufficiently, hand brush coating to work into all recesses provided that the maximum DFT is not exceeded.
15. Backroll surfaces if coatings are spray applied.

B. Employ services of coating manufacturer's technical representative to ensure that field-applied coatings are compatible with factory-applied or existing coatings.
    1. Certify through material data sheets.
    2. Perform test patch.
        a. Prepare existing coating surface to receive specified coating system.
        b. Apply coating to a minimum 1 square feet area and allow to cure in accordance with manufacturer's recommendations.
        c. Evaluate adhesion to existing coating:
            1) Concrete or Masonry substrates: ASTM D4541.
            2) All other substrates: ASTM D6677 and ASTM D3359 (X-cut method).
    3. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
        a. Perform test patch as described above.
    4. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate coating system listed in the MATERIALS Article, Coating Systems paragraph of this Specification Section.
        a. All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Owner.

C. Prime Coat Application:
    1. Apply structural steel and miscellaneous steel prime coat in the factory.
        a. Finish coats shall be applied in the field.
        b. Prime coat referred to here is prime coat as indicated in this Specification.
            1) Prime coating applied in factory (shop) as part of Fabricator's standard rust inhibiting and protection coating is not acceptable as replacement for specified prime coating.
    2. Prime all surfaces indicated to be coated.
        a. Apply prime coat in accordance with coating manufacturer's written instructions and as written in this Specification Section.
    3. Prime ferrous metals embedded in concrete to minimum of 1 inch below exposed surfaces.

4. Apply zinc-rich primers while under continuous agitation.
5. Brush or spray bolts, welds, edges and difficult access areas with primer prior to primer application over entire surface.
6. Touch up damaged primer coats prior to applying finish coats.
   a. Restore primed surface equal to surface before damage.
7. All surfaces of steel lintels and steel components of concrete lintels used in wall construction shall be completely coated with both prime and finish coats prior to placing in wall.

D. Finish Coat Application:

1. Apply finish coats in accordance with coating manufacturer's written instructions and in accordance with this Specification Section; manufacturer instructions take precedent over these Specifications.
2. Touch up damaged finish coats using same application method and same material specified for finish coat.
   a. Prepare damaged area in accordance with the PREPARATION Article of this Specification Section.

3.6 COLOR CODING

A. Color code piping in accordance with the SCHEDULE Article of this Specification Section.

3.7 FIELD QUALITY CONTROL

A. Application Deficiencies:

1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.
   a. Epoxy surfaces showing evidence of chalking or amine blush shall be prepared and recoated as follows:
      1) Solvent clean surfaces in accordance with SSPC-SP1 and abrasive blast in accordance with SSPC-SP7/ NACE No. 4.
      2) Recoat with intermediate and finish coats in accordance with coating system specified herein.

B. Provide protection for coated surfaces.

1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Contractor Performed Testing:

1. Provide ongoing testing and inspection, including but not limited to the following:
   a. Measurement and recording of environmental conditions as specified herein.
   b. Measurement and recording of substrate conditions as specified herein.
   c. Thickness Testing:
      1) Wet film thickness during application in accordance with ASTM D4414.
      2) Dry Film Thickness (DFT) in accordance with SSPC-PA 2.
      3) Engineer may measure coating thickness at any time during project to assure conformance with these Specifications.
   d. Bond Strength:
      1) Additional bond strength testing will be required by the Engineer where there is reason to suspect the integrity of the coating system.
      2) Measure bond strength of the coating in accordance with:
         a) Steel substrate: ASTM D4541.

b) Concrete substrate ASTM D7234.

3) The number of test sites and locations to be tested shall be determined by the Engineer after application of coating. The Contractor will apply the dollies, perform the tests and repair the coating in the presence of the Engineer.

a) For each test that fails, two additional tests shall be performed in the adjacent area.

b) Further bond tests may be performed to determine the extent of potentially deficient bonded areas at no additional cost to the Owner.

4) Repairs shall be made by applicator in strict accordance with manufacturer's recommendations. Any coated areas that do not pass the bond strength tests shall be removed and replaced at the expense of the Contractor.

D. NACE inspection:

1. The Owner reserves the right to retain a NACE Level 3 coating inspector to perform observation, inspection and testing as deemed necessary to document the quality of the Work.

a. All work shall be done to the satisfaction of the Owner's inspector.

b. Any portion of the coating that does not satisfactorily pass the inspection and testing requirements shall be repaired or replaced by the Contractor at no additional cost to the Owner.

c. Additional testing and/or inspection may be done at the discretion of the Owner.

1) The Contractor will provide all equipment, materials, and labor to perform the testing.

2. Inspection, testing or observation by the Owner's inspector shall not relieve the Contractor of responsibility for surface preparation, inspection or quality control specified herein.

E. Instrumentation:

1. Provide instrumentation as necessary to measure and record atmospheric and substrate conditions, including but not limited to:

a. Dry Film Thickness Gauge:

1) Ultrasonic: ASTM D6132.

2) Magnetic: ASTM B499.

b. Wet Film Thickness Gauge: ASTM D4414.

c. Sling Psychrometer: ASTM E337.

d. Surface Temperature Gauge.

e. Anemometer.

f. Moisture Meter.

g. Adhesion test apparatus:

1) Steel: ASTM D4541.

2) Concrete: ASTM D7234.

F. Maintain Daily Records:

1. Record the following information during application:

a. Date, starting time, end time, and all breaks taken by applicators.

b. Air temperature.

c. Relative humidity.

d. Dew point.

e. Moisture content and pH level of concrete or masonry substrates prior to coating.

f. Surface temperature of substrate.

g. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling,

dehumidification and provisions utilized to mitigate wind-blown dust and debris from contaminating the wet coating.

h. For outdoor coating, also record:
   1) Sky condition.
   2) Wind speed and direction.

i. Record environmental conditions, substrate moisture content and surface temperature information not less than once every 4 hours during application.
   1) Record hourly when temperatures are below 50 degrees F or above 100 degrees F.

2. Record the following information daily for the coating manufacturer's recommended curing period:
   a. Date and start time of cure period for each item or area.
   b. For outdoor coating, also record:
      1) Sky conditions.
      2) Wind speed and direction.
      3) Air temperature.
         a) Dry Bulb.
         b) Wet Bulb.
      4) Relative humidity.
      5) Dew point.
      6) Surface temperatures.
   c. Record environmental conditions not less than once every 4 hours.
      1) Record hourly when temperatures are below 50 degrees F or above 100 degrees F.
   d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.
3. Format for daily record to be computer generated.

G. Provide wet paint signs.

3.8 CLEANING

A. Clean coating spattered surfaces.
   1. Use care not to damage finished surfaces.

B. Upon completion of coating, replace hardware, accessories, plates, fixtures, and similar items.

C. Remove surplus materials, scaffolding, and debris.

3.9 COLOR SCHEDULE

A. Pipe Bollards: Safety Yellow.

B. Piping:
   1. Refer to Specification Section 10 14 00 for the piping system and banding material and refer to this Specification Section and this Schedule for the banding colors.

END OF SECTION

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DIVISION 10

SPECIALTIES

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SECTION 10 14 00
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items.
2. Hazard, project and safety signs.

B. Related Specification Sections include but are not necessarily limited to:

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. A13.1, Scheme for the Identification of Piping Systems.
2. The International Society of Automation (ISA).
3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
   a. Z535.1, Safety Color Code.
   b. Z535.2, Environmental and Facility Safety Signs.
   c. Z535.3, Criteria for Safety Symbols.
   d. Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 704, Standard System for the Identification of Hazards of Materials for Emergency Response.
5. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Catalog information for all identification systems.
   b. Acknowledgement that products submitted meet requirements of standards referenced.
2. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.
3. Schedule of Hazard and Safety Signage indicating text and graphics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. W.H. Brady Co.
2. Panduit.
3. SmartSign.
4. Seton.

5. National Band and Tag Co.
6. Carlton Industries, Inc.
7. Or equal.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:
   1. Materials:
      a. Aluminum or stainless steel.
      b. Stainless steel shall be used in corrosive environments.
   2. Size:
      a. Diameter: 1-1/2 inches minimum.
      b. Thickness: 0.035 inches (20 GA) minimum.
   3. Fabrication:
      a. 3/16 inches minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:
   1. Materials: Stainless steel.
   2. Size:
      a. 3-1/2 inches x 1-1/2 inches minimum.
      b. Thickness: 0.036 inches (20 GA) minimum.
   3. Fabrication:
      a. 3/16 inches minimum mounting hole.
      b. Legend: Stamped and filled with black coloring.
   4. Color: Natural.

C. Type A3 - Metal Tape Tags:
   1. Materials: Aluminum or stainless steel.
   2. Size:
      a. Width 1/2 inches minimum.
      b. Length as required by text.
   3. Fabrication:
      a. 3/16 inches minimum mounting hole.
      b. Legend: Embossed.
   4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:
   1. Materials: Fiberglass reinforced plastic.
   2. Size:
      a. Surface: 2 x 2 inches minimum.
      b. Thickness: 100 mils.
   3. Fabrication:
      a. 3/16 inches mounting hole with metal eyelet.
      b. Legend: Preprinted and permanently embedded and fade resistant.
   4. Color:
      a. Background: Manufacturer standard or as specified.
      b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:

1. Materials: Fiberglass reinforced or durable plastic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 60 mils minimum.
3. Fabrication:
   a. Rounded corners.
   b. Drilled holes in corners with grommets.
   c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
4. Color:
   a. Background: Manufacturer standard or as specified.
   b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Laminated Name Plates:

1. Materials: Phenolic or DR (high impact) acrylic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 1/16 inches.
3. Fabrication:
   a. Outdoor rated and UV resistant when installed outdoors.
   b. Two layers laminated.
   c. Legend: Engraved through top lamination into bottom lamination.
   d. Two drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:

1. Materials: Vinyl tape or vinyl cloth.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 5 mils minimum.
3. Fabrication:
   a. Indoor/Outdoor grade.
   b. Weather and UV resistant inks.
   c. Permanent adhesive.
   d. Legend: Preprinted.
   e. Wire markers to be self-laminating.
4. Color: White with black lettering or as specified.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:

1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
   a. Legend: Preprinted.

4. Color: White background, black printing.

I. Type F - Underground Warning Tape:

1. Materials: Polyethylene.
2. Size:
   a. 6 inches wide (minimum).
   b. Thickness: 3.5 mils.
3. Fabrication:
   a. Legend: Preprinted and permanently imbedded.
   b. Message continuous printed.
   c. Tensile strength: 1750 psi.
4. Color: As specified.

J. Type G - Stenciling System:

1. Materials:
   a. Exterior type stenciling enamel.
   b. Either brushing grade or pressurized spray can form and grade.
2. Size: As required.
3. Fabrication:
   a. Legend: As required.
4. Color: Black or white for best contrast.

K. Underground Tracer Wire:

1. Materials:
   a. Wire:
      1) 12 GA AWG.
      2) Solid.
   b. Wire nuts: Waterproof type.
   c. Split bolts: Brass.

2.3 ACCESSORIES

A. Fasteners:

1. Bead chain: #6 brass, aluminum or stainless steel.
2. Plastic strap: Nylon, urethane or polypropylene.
3. Screws: Self-tapping, stainless steel.
4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 inches round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.

1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.

1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:

1. Attach to pipe at a maximum of 10 feet intervals with tape or tie-wraps.
2. Continuous pass from each valve box and above grade at each structure.
3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
4. 1,000 feet maximum spacing between valve boxes.
5. If split bolts are used for splicing, wrap with electrical tape.
6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 inches of wire for splicing.
7. Use continuous strand of wire between valve box where possible.
   a. Continuous length shall be no shorter than 100 feet.

3.2 SCHEDULES

A. Project Signage:

1. Project Identification:
   a. 3/4-inch exterior high density overlaid plywood with exterior type enamel.
   b. Mount: Two 12-foot-long, 4-inch by 4-inch, pressure-treated hem fir wood posts. Posts shall be buried 4-feet into ground and sign shall be mounted 4-feet above ground surface. Contractor shall maintain throughout project.
   c. Fastener: Screw or bolt.
   d. Size: 8-foot-wide x 4-foot-high.
   e. Location: Field located as directed by Engineer.
   f. Legend:
      1) Sign shall bear name of Project and Owner and include logos for the Owner, Tribe, Engineer and Contractor.
      2) Lettering shall be blue applied on white background by an experienced sign painter.
      3) Logos shall be in full color.
      4) Information to be included and logo graphics will be provided by the engineer.

B. Hazard and Safety Signage:

1. Miscellaneous OSHA hazard signage:
   a. 40 mil Aluminum.
   b. Fastener: Screw or adhesive.
   c. Size: 10 inches x 14 inches or as indicated below or on the drawings.
      1) 18 x 24 inches Aluminum: Danger Do Not Enter/Peligro No Entre

2) 18 x 18 inches Aluminum: U.S. Property No Trespassing

3) 12 x 18 inches Aluminum: Attention No Swimming

d. Location: As indicated on Drawings.

e. Location: Field located as directed by Engineer.

1) Allowance: Provide 5 OSHA Danger, Caution, Safety Instruction or Biohazard signs as directed by Engineer.

f. Legend:

1) Description of hazard shall be determined by Engineer.

2) Provide international graphic symbology where indicated.

2. No Smoking Signage:

a. Tag Type: Type B2 - Nonmetallic Signs.

b. Fastener: Screw or adhesive.

c. Size: 10 inches x 14 inches.

d. Location: On the doors entering into buildings.

e. Location: Field located as directed by Engineer.

1) Allowance: Provide 5 “NO SMOKING” signs.

f. Legend: “NO SMOKING” with international graphic symbology, adhering to the International Fire Code.

C. Process Systems:

1. General:

a. Provide arrows and markers on piping.

1) At 20 feet maximum centers along continuous lines.

2) At changes in direction (route) or obstructions.

3) At valves, risers, "T" joints, machinery or equipment.

4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.

b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
    1) If flow is in both directions use double headed arrow markers.
c. Apply tapes and stenciling in uniform manner parallel to piping.

2. Trenches with piping:
    a. Tag type: Type F - Underground Warning Tape
    b. Location: Halfway between top of piping and finished grade.
    c. Letter height: 1-1/4 inches minimum.
    d. Propane gas:
        1) Color: Yellow with black letters.
        2) Legend:
            a) First line: “CAUTION CAUTION CAUTION”
            b) Second line: “BURIED GAS LINE BELOW”
    e. (Nonpotable) water piping, except 3 inches and smaller irrigation pipe:
        1) Color: Green with black letters.
        2) Legend:
            a) First line: “CAUTION CAUTION CAUTION”
            b) Second line: “BURIED NONPOTABLE WATER LINE BELOW”
3. Valves and slide gates:
    a. Tag type:
        1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
        2) Indoor noncorrosive:
            a) Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
        3) Indoor corrosive:
            a) Stainless steel Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
    b. Fastener:
        1) Type A1: Chain of the same material.
        2) Type B1: Stainless steel chain.
    c. Color: Per ASME A13.1 corresponding to the piping system.
    d. Legend:
        1) Letter height: 1/4 inches minimum.
        2) Valve designation as indicated on the Drawings (e.g., “V-xxx”).
4. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Tags and Signs.
        3) Type G - Stenciling System.
    b. Fastener:
        1) Self.
        2) Screws.
        3) Adhesive.
    c. Legend:
        1) Letter height: 1/2 inches minimum.

2) Equipment designation as indicated on the Drawings (e.g., “Primary Sludge Pump P-xxx”).

5. Piping systems:
   a. Tag type:
      1) Outdoor locations: Type G - Stenciling System.
      2) Indoor locations:
         a) Type D - Self-Adhesive Tape Tags and Signs.
         b) Type G - Stenciling System.
   b. Fastener: Self.
   c. Color: Per ASME A13.1.
   d. Legend:
      1) Letter height: Manufacturers standard for the pipe diameter.
      2) Mark piping in accordance with ASME A13.1.
      3) Use piping designation as indicated on the Drawings.
      4) Arrow: Single arrow.
6. Tanks (less than 1000 GAL) (e.g., break tanks, chemical tanks, hydro-pneumatic tanks, air receivers, etc.):
   a. Tag type:
      1) Type D - Self-Adhesive Tape Tags and Signs.
      2) Type G - Stenciling System.
   b. Fastener: Self.
   c. Legend:
      1) Letter height: 2 inches minimum.
      2) Equipment designation as indicated on the Drawings (e.g., “Air Storage Tank Txxx”)
7. Equipment that starts automatically:
   a. Tag type:
      1) Type B2 - Nonmetallic Signs.
      2) Type D - Self-Adhesive Tape Tags and Signs.
   b. Fastener:
      1) Type B2 - Screw or adhesive.
      2) Type D - Self.
   c. Size: 5 inches x 7 inches
   d. Location: Equipment name.
   e. Legend:
      1) OSHA Warning Sign.
      2) Description of Warning: “THIS MACHINE STARTS AUTOMATICALLY”.

D. Instrumentation Systems:
   1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
      a. Tag type:
         1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
         2) Indoor noncorrosive:
            a) Type A1 - Round Metal Tags.
            b) Type B1 - Square Nonmetallic Tags.
            c) .
      b. Fastener:
         1) Type A1: Chain of the same material.

2) Type B1: Stainless steel chain.

c. Legend:

1) Letter height: 1/4 inches minimum.

2) Equipment ISA designation as indicated on the Drawings (e.g., “FIT-xxx”).

2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/2 inches minimum.

2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").

3. Components inside equipment enclosure, (e.g., PLC’s, control relays, contactors, and timers):

a. Tag type: Type D - Self-Adhesive Tape Tags.

b. Fastener: Self.

c. Legend:

1) Letter height: 3/16 inches minimum.

2) Description or function of component (e.g., "PLC-xxx” or “CR-xxx").

4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/4 inches minimum.

2) Component ISA tag number as indicated on the Drawings (e.g., “HS-xxx”).

E. HVAC Systems:

1. HVAC Equipment (e.g., unit heaters, exhaust fans, air handlers, etc.):

a. Tag type:

1) Type B2 - Nonmetallic Signs.

2) Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1 inch minimum.

2) Equipment designation as indicated on the Drawings (e.g., "EF-xxx").

2. Enclosure for instrumentation and control equipment, (e.g., fan control panels, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/2 inches minimum.

2) Equipment designation as indicated on the Drawings (e.g., "FAN CONTROL PANEL FCP-xxx").

3. Wall mounted thermostats:

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener: Self.

c. Legend:

1) Letter height: 3/16 inches minimum.

2) Description of equipment controlled (e.g., "UH-xxx" or AHU-xxx").

4. Components inside equipment enclosure, (e.g., controller's, control relays, contactors, and timers):
    a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
    b. Fastener: Self.
    c. Legend:
        1) Letter height: 3/16 inches minimum.
        2) Description or function of component (e.g., "CR-xxx").

F. Electrical Systems:

1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
    a. Tag type: Type F - Underground Warning Tape.
    b. Letter height: 1-1/4 inches minimum.
    c. Location:
        1) Where trench is 12 inches or more below finished grade: In trench 6 inches below finished grade.
        2) Where trench is less than 12 inches below finished grade: In trench 3 inches below finished grade.
    d. Electrical power (e.g., low and medium voltage):
        1) Color: Red with black letters.
        2) Legend:
            a) First line: "CAUTION CAUTION CAUTION".
            b) Second line: "BURIED ELECTRIC LINE BELOW".
    e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
        1) Color: Orange with black letters.
        2) Legend:
            a) First line: "CAUTION CAUTION CAUTION".
            b) Second line: "BURIED COMMUNICATION LINE BELOW".
2. Exterior pad mounted equipment (e.g., transformers, switchgear):
    a. Tag type: Type D - Self-Adhesive Tape Tags.
    b. Fastener: Self.
    c. General legend:
        1) Letter height:
            a) First line: 1-1/2 inches minimum.
            b) Subsequent lines: 1/2 inches minimum.
        2) First line: Equipment name (e.g., "TRANSFORMER Txxx").
        3) Second line: System voltage (e.g., "13,800 V: 480/277 V").
        4) Third line: Date installed (e.g., "INSTALLED JULY 20xx").
3. Switchgear, switchboards and motor control centers:
    a. Tag type: Type C - Phenolic Name Plates.
    b. Fastener: Screws.
    c. Main equipment legend:
        1) Letter height:
            a) First line: 1 inch minimum.
            b) Subsequent lines: 3/8 inches minimum.
        2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").
        3) Second line:
            a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").

b) Include the building name or number if the source is in another building.
4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).
5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).
d. Main and feeder device legend:
1) Letter height: 3/8 inches minimum.
2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HPxxx").
4. Panelboards and transformers:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height:
a) First line: 3/8 inches minimum.
b) Subsequent lines: 3/16 inches minimum.
2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
3) Second line (panelboards only): System voltage and phase (e.g., “208/120V, 3PH”).
4) Third line:
a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
b) Include the building name or number if the source is in another building.
5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).
5. Transfer switches:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height:
a) First line: 3/8 inches minimum.
b) Subsequent lines: 3/16 inches minimum.
2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").
3) Second line: Normal source of power (e.g., "NORMAL SOURCE FED FROM MCCxxx").
4) Third line: Emergency source of power (e.g., "EMERGENCY SOURCE FED FROM SGENxxx").
5) Fourth line: Date installed (e.g., “INSTALLED JULY 20xx”).
6. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/4 inches minimum.
2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
3) Second line:
a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
b) The source of power room number is only required when there are multiple electrical rooms, if the source is in another building, the building name or number shall be used.
7. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.
c. Legend:
1) Letter height: 1/2 inches minimum.
2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").

8. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
b. Fastener: Self.
c. Legend:
1) Letter height: 3/16 inches minimum.
2) Description or function of component (e.g., "M-xxx", “CR-xxx” or “TR-xxx").

9. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
a. Tag type: Type C - Phenolic Name Plates.
b. Fastener: Screws.
c. Legend:
1) Letter height: 1/4 inches minimum.
2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).

10. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
a. Tag type: Type E - Heat Shrinkable Tape Tags.
b. Fastener: Self.
c. Tag conductor at both ends.
d. Legend:
1) Letter height: 1/8 inches minimum.
2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.

11. Conductors in handholes and manholes.
a. Tag type: Type A3 - Metal Tape Tags.
b. Fastener: Nylon strap.
c. Tag conductor at both ends.
d. Legend:
1) Letter height: 1/8 inches minimum.
2) Circuit number or wire number as scheduled on the Drawings.

12. Grounding conductors associated with grounding electrode system in accordance with the following:
a. Tag type: Type D - Self-Adhesive Tape Tags.
b. Fastener: Self.
c. Legend:
1) Letter height: 1/8 inches minimum.
2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").

13. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
a. Tag type: Type D - Self-Adhesive Tape Signs.
b. Fastener: Self.
c. Legend: Per NFPA 70.

14. Poles:

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
b. Fastener:
    1) Metal pole: Self.
c. Color: Yellow with black letters.
d. Legend:
    1) Letter height: 1 inch minimum.
    2) Pole number to match lighting or camera numbering installed on the pole.

15. Equipment where more than one voltage source is present:
    a. Tag type:
        1) Type B2 - Nonmetallic Signs.
        2) Type D - Self-Adhesive Tape Signs.
    b. Fastener:
        1) Screw or adhesive.
        2) Self.
    c. Size: 1-3/4 inches x 2-1/2 inches.
    d. Location: Exterior face of enclosure or cubical.
    e. Legend:
        1) OSHA Danger Sign.
        2) Description of Danger: “MULTIPLE VOLTAGE SOURCES”.

END OF SECTION

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SECTION 10 14 23
SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Room identification signs.
2. Other identification signs:
   a. Fire and/or smoke barrier identification signs.
3. Aluminum letters.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 10 14 00 - Identification Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Americans with Disabilities Act (ADA):
   a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
2. ASTM International (ASTM):
   a. B26, Standard Specification for Aluminum-Alloy Sand Castings.

1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

B. Wet and/or Corrosive Areas: For the purposes of this Specification Section, the following rooms or areas are considered wet and/or corrosive:

1. Room 101 Pump Gallery.
2. Room 102 Valve Vault.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Color charts for Engineer's color selection.
      1) Color selection shall be made from manufacturer's complete color line including all premium and special colors.
2. Schedule of all signs indicating text and graphics.
3. Layout drawings of all signage showing size, letter style, text, border, finish, and installation detail.
   a. Provide drawings for:
      1) Room and exit identification signs.
      2) Aluminum letters.

B. Samples:

1. Room and exit identification signs.
2. Aluminum letters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Room and exit identification signs:
   a. ASE - Architectural Signs and Engraving.
   b. ASI Signage Innovations.
   c. Best Sign Systems.
   d. Mohawk Sign Systems.
   e. Nelson-Harkins.
   f. Southwell Co.
   g. Stamprite Supersine Identification Specialists.
2. Fire and/or smoke barrier identification signs:
   a. Brady.
   b. Panduit.
   c. Seton.
   d. Carlton Industries.
3. Aluminum letters:
   a. A R K Ramos Manufacturing Co., Inc.
   b. ASI Signage Innovations.
   c. Leeds Architectural Letters.
   d. Metal Arts.
   e. Metallic Arts.
   f. The Southwell Co.

2.2 MATERIALS

A. Room and exit identification signs:

1. Interior:
   a. Dry, non-corrosive areas: Melamine plastic suitable for raised lettering.
   b. Wet and/or corrosive areas: Aluminum or fiberglass suitable for raised lettering.
2. Exterior: Aluminum or fiberglass suitable for raised lettering.

B. Aluminum Letters:

1. Cast aluminum ASTM B26.
2. For machine cut letters, provide aluminum of appropriate alloy and hardness.

2.3 FABRICATION

A. Room and exit identification signs:

1. General:
   a. Raised text, border and graphics.
      1) Minimum 1/32 inches height.
      2) Provide international graphic symbology for all toilet, locker and shower rooms or combinations thereof, and for unisex toilet rooms and stairs.
      3) Provide handicap symbol on all signs for rooms meeting handicap requirements.
   b. Finish: Eggshell.
      1) Color: To be selected.
   c. Text:

1) Typeface: Sans Serif.
2) Size: Minimum 3/4 inches high.

d. Text as indicated in the SCHEDULES Article in PART 3 of this Specification Section.

e. Exterior signs shall be rated for exterior use.

2. Typeface: Helvetica Medium.

3. Text Size:

a. Height: 3 inches minimum.

b. Stroke: 3/8 inches minimum.

c. Text: As indicated in the SCHEDULES Article in PART 3Fabrication:

B. Hazard Communication Signage (NFPA and OSHA signage): See Specification Section 10 14 00.

C. Aluminum Letters:

1. General:

a. Cast aluminum, machine cut or laser cut aluminum.

b. Finish: Anodized.

c. Color: Anodized.

d. Mounting:

1) 1 inches projected.

2) Provide stainless steel mounting studs.

e. Text: As indicated in the SCHEDULES Article in PART 3.

2. Letters:

a. Typeface: Match existing facility signage.

b. Size:

1) Height: 8 inches.

2) Stroke: 1/2 inches minimum.

c. Depth: 3/8 inches.

3. Provide true angles, crisp corners and straight edges with no burrs or pitting in the surface.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Room Identification Signs:

1. Install signs using foam tape for interior signs and stainless steel screws (minimum of two) for exterior signs.

a. Stainless steel screws shall be painted to match sign color.

2. Mounting Locations:

a. Tactile characters on signs shall be located 48 inches minimum above the finished floor or ground surface, measured from the baseline of the lowest tactile character and 60 inches maximum above the finish floor or ground surface, measured from the baseline of the highest tactile character.

b. Where a tactile sign is provided at a door, the sign shall be located alongside the door at the latch side. Where a tactile sign is provided at double doors with one active leaf, the sign shall be located on the inactive leaf. Where a tactile sign is provided at double doors with two active leafs, the sign shall be located to the right side of the right hand

door. Where there is no wall space at the latch side of a single door or at the right side of double doors, signs shall be located on the nearest adjacent wall.

c. Signs containing tactile characters shall be located so that a clear floor space of 18 inches minimum by 18 inches minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.

B. Aluminum Letters:

1. Install letters where indicated on Drawings.
2. Mount to walls with 1 inch projection in accordance with manufacturer's instructions.

3.2 SCHEDULES

A. Room and Exit Identification Signs:

1. Door 101.1
   a. Pull side: “PUMP GALLERY”
   b. Push side: “EXIT”
2. Door 101.2
   a. Pull side: “PUMP GALLERY”
   b. Push side: “UTILITY”
3. Door 101.3 – no signage.
4. Door 101.4
   a. Pull side: “PUMP GALLERY”
   b. Push side: “EXIT”
5. Door 102.1
   a. Pull side: “VALVE VAULT”
   b. Push side: “EXIT”
6. Door 102.1
   a. Pull side: “VALVE VAULT”
   b. Push side: “UTILITY”
7. Door A101
   a. Pull side: “ELECTRICAL ROOM”
   b. Push side: no signage.

B. Aluminum Letters:

1. As indicated on the Drawings.
   a. Provide and install up to twenty (20) characters for Electrical Building.
   b. Final configuration shall be set at submittal review.
   c. No exterior aluminum letter signage for Pump Building.

END OF SECTION

SECTION 10 44 33
FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Portable fire extinguishers.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 05 50 00 - Metal Fabrications.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Fire Protection Association (NFPA):
   a. 10, Standard for Portable Fire Extinguishers.
2. Underwriters Laboratories, Inc. (UL):
   a. 8, Water Based Agent Fire Extinguishers.
   b. 154, Carbon Dioxide Fire Extinguishers.
   c. 299, Dry Chemical Fire Extinguishers.
   d. 626, Water Fire Extinguishers.
   e. 711, Rating and Fire Testing of Fire Extinguishers.
   f. 2129, Halocarbon Clean Agent Fire Extinguishers.

1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Ratings and classification of extinguishers.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and install filled and charged extinguishers just prior to building occupancy.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Fire extinguishers:
   a. Amerex Corporation.
   b. Ansul – Tyco Fire Protection Products.
   c. Badger Fire Protection.
   d. United Technologies - Kidde.
   e. Buckeye Fire Equipment.

2. Fire extinguisher signs:
    a. Seton.
    b. Compliance Signs.
    c. Safety Sign.

2.2 MANUFACTURED UNITS

A. Fire Extinguisher (FEXT):
    1. Steel bodied, all metal top (head) and valves.
    2. Multi-purpose dry chemical extinguisher with hose and nozzle.
    3. Provide one listed 10 pound. 4A-60BC extinguisher for each fire extinguisher location (FEXT) indicated on Drawings.
    4. Finish: Red with epoxy finish coat.

B. Wall Brackets:
    1. Bracket type to fit specified extinguisher.
    2. Furnish bracket for each extinguisher not in cabinet.
    3. Bracket to be finished in red or black enamel.

C. Fire Extinguisher Signage:
    1. Single faced: SETON #21999.
    2. Double faced: SETON #22001.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and NFPA 10.
    1. Install units with extinguisher top not over 48 inches above floor.
    2. Install wall brackets to concrete or masonry substrate with self-tapping concrete anchors.
        a. See Specification Section 03 15 19.

B. Fire extinguisher locations shown on Drawings are approximate locations.
    1. Verify all extinguisher mounting locations with the AHJ.

C. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.
    1. Provide single or double faced sign to provide optimum visibility for extinguisher location.

END OF SECTION

DIVISION 22

PLUMBING

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SECTION 22 15 00

GENERAL SERVICE COMPRESSED-AIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Compressed air piping.
2. Valves.
3. Pipe hangers and supports.
4. Flexible connectors.
5. Compressed air outlets.
6. Air compressor.
7. Air receiver.
8. Pressure regulators.
9. Compressed air filters.
10. Hose connectors.

1.2 QUALITY ASSURANCE

A. Reference Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B16.3, Malleable Iron Threaded Fittings.
   b. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   c. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   d. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
2. ASTM International (ASTM):
   a. B88, Standard Specification for Seamless Copper Water Tube.
   b. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   c. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
   d. F1281, Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.
   e. F1282, Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
   f. F1476, Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
3. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   a. SP 58, Pipe Hangers and Supports - Materials, Design and Manufacturer.
   b. 67, Butterfly Valves.
   c. SP 69, Pipe Hangers and Supports - Selection and Application.
   d. SP 70, Cast Iron Gate Valves, Flanged and Threaded Ends.
   e. SP 71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
   f. SP 80, Bronze Gate, Globe, Angle and Check Valves.
   g. SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.
   h. SP 110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

B. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Indicate piping system schematic with electrical and connection requirements general assembly of components, mounting and installation details, and general layout of control and alarm panels.

C. Product Data:

1. Piping: Submit data on pipe materials, fittings, and accessories.
2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
4. System Components: Submit manufacturers catalog information including capacity, component sizes, rough-in requirements, and service sizes. When applicable, include electrical characteristics and connection requirements.
5. Compressors: Submit type, capacity, and performance characteristics. Include electrical characteristics and connection requirements.

D. Product Data: Submit manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.

E. Manufacturer's Installation Instructions: Submit hoisting and setting requirements, starting procedures.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

G. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 QUALIFICATIONS

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Accept equipment on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

B. Protect piping and equipment from weather and construction traffic. Maintain factory packaging and caps in place until installation.

C. Deliver each length of piping with manufacturer’s plugged or capped ends and keep sealed until installation.

D. Deliver fittings, valves, and other components in sealed containers and keep sealed until installation.

1.6 WARRANTY

A. Section 01 78 36 - Warranties.

B. Furnish five year manufacturer warranty for pumps, compressors, refrigerated dryers and valves excluding packing.

PART 2 - PRODUCTS

2.1 COMPRESSED AIR PIPING

A. Copper Tubing: ASTM B88, Type M drawn.

1. Fittings: ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze.
2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
3. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder or AWS A5.8 Classification BCuP-3 or BCuP-4 silver braze.

B. Copper Tubing: ASTM B88, Type M drawn.

1. Copper Press Fittings: Conforming to ASME B16.18 cast copper alloy or ASME B16.22, wrought copper and bronze with Nitrile O-ring seals.
2. Joints: Compression type made with manufacturer's tool.

C. Copper Tubing: ASTM B88, Type M drawn, rolled grooved ends.

1. Fittings: ASME B16.18 cast copper alloy,] or ASME B16.22 wrought copper and bronze, or ASTM B584 bronze sand castings, grooved ends.
2. Joints: Grooved mechanical couplings meeting ASTM F1476.
   a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
   b. Gasket: Elastomer composition for operating temperature range from 86 DEGF to 180 DEGF.
   c. Accessories: Steel bolts, nuts, and washers.

D. Aluminum Piping: Powder coated rigid aluminum pipe of AW-6060 T51 or AW-6063 T5, ASME B31.1 & B31.3

1. Fittings: Grip-ring with half-turn release nut and torque indicator, compression style or clamshell
2. Joints: Press type, compression style or clamshell
3. Flexible hose for compressor outlet

2.2 BALL VALVES

A. Manufacturers:

1. Apollo Valves by Conbraco Industries, Inc.
2. Crane ChemPharma Energy.
3. DynaQuip Controls, Inc.
4. Flow-Tek, Inc.
5. FNW by Ferguson Enterprises, Inc.
6. Hammond Valve.
7. Jamesbury by Metso Corporation.
8. Jenkins Valves by Crane ChemPharma Energy.
9. Jomar Valve.
10. KITZ Corporation.
11. Legend Valve & Fitting, Inc.
12. Marwin Valve by Richards Industries.
13. Milwaukee Valve Company.
14. NIBCO, Inc.
15. Red-White Valve Corp.
16. Stockham by Crane ChemPharma Energy.

17. Zurn Industries, LLC.

B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, threaded ends with union, locking lever handle.

2.3 PIPE HANGERS AND SUPPORTS

A. Manufacturers:

1. CADDY by nVent.
2. Carpenter & Paterson, Inc.
3. Empire Industries, Inc.
4. Globe Pipe Hanger Products, Inc.
5. Haydon Corporation.
6. Hilti, Inc.
7. NIBCO, Inc.
8. PHD Manufacturing, Inc.
9. Parker Transair

B. Conform to ASME B31.9.

C. Hangers for Pipe Sizes 1/2 to 1-1/2 inches: Malleable iron or Carbon steel, adjustable swivel, split ring, or black nickel plated brass.

D. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

F. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.

G. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.

H. Vertical Support: Steel riser clamp.

I. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

J. Copper Pipe Support: Copper-plated, carbon steel ring.

2.4 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Flex-Hose Co., Inc.
2. Flex-Weld, Inc.
3. Hyspan Precision Products, Inc.
4. Twin City Hose, Inc.

B. 2 inches and Smaller: Corrugated bronze or stainless steel hose with single layer of bronze or stainless steel exterior braiding; threaded or soldered connections.

2.5 COMPRESSED AIR OUTLETS

A. Manufacturers:

1. Ingersoll-Rand PLC.
2. RapidAir by Engineered Specialties, LLC.

B. Compressed Air Outlets: Provide ball valves and brass quick connect fittings at all air outlet locations. Provide a matching hose side quick connect fitting at each air outlet. Quick Connector: 1/4 inches brass, snap on connector with self closing valve, Style M.

2.6 AIR COMPRESSOR

A. Manufacturers:

1. Atlas Copco LLC.
2. Curtis-Toledo, Inc.
3. Gardner Denver, Inc.
4. Ingersoll-Rand PLC.
5. Kaeser Compressors.
6. Powerex, Inc.
7. Quincy Compressor.
8. Saylor-Beall, Inc.

B. Air Compressor: tank mounted compressor unit consisting of air-cooled compressor, air receiver, and operating controls.

C. Screw Compressors:

1. Unit: Belt drive, fixed compression, rotary screw compressor with control panel.
2. Control Panel: Factory mounted and wired NEMA 250 Type 1 enclosure, with starter controls including:
   a. Non-fused molded-case, disconnect switch.
   b. Single point power connection and grounding lug.
   c. Solid state overload relay for each compressor.
   d. Automatic shutdown on compressor overload.

D. Capacity:

1. Continuous Delivery: 38 minimum CFM of free air.
2. Discharge Conditions: 100 PSI at 4,450 feet altitude.

E. Electrical Characteristics:

1. 10 HP.
2. 460 volts, three phase, 60 Hz.

F. Controls:

1. Pressure Switch: Line voltage contactor to break at 100 psi with minimum differential of 20 psi.

G. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.

H. Disconnect Switch: Factory mount on equipment under provisions of Section 26 05 00.

I. Cord and Plug: Furnish unit with cord and plug for connection to electric wiring system including grounding connector.

2.7 AIR RECEIVER

A. Manufacturers:

1. Kaeser Compressors.
2. Powerex, Inc.
3. Or equal

B. Air Receiver: Horizontal, built to ASME Section VIII regulations for working pressure of 125 psi. Flange or screw inlet and outlet connections.

C. Fittings: Adjustable pressure regulator, safety valve, pressure gage, drain valve, and automatic float actuated condensate trap.

D. Tank Finish: Shop primed.

E. Size:

1. Capacity: 120 GAL.

2.8 PRESSURE REGULATORS

A. Manufacturers:

1. Dixon Valve and Coupling.
2. Fisher by Emerson Electric Co.
3. Parker Hannifin Corp.
4. RapidAir by Engineered Specialties, LLC.
5. Spirax-Sarco, Inc.

B. Pressure Regulators: Bronze body, direct acting, spring loaded, manual pressure setting adjustment, rated for 250 psiG inlet pressure.

C. Pressure Regulators: Aluminum alloy or plastic body, diaphragm operated, direct acting, spring loaded, manual pressure setting adjustment, and rated for 250 psiG inlet pressure.

2.9 COMPRESSED AIR FILTERS

A. Manufacturers:

1. AIR/TAK, Inc.
2. Curtis-Toledo, Inc.
3. Kaeser Compressors.
4. Parker Hannifin Corp.
5. ZEKS Compressed Air Solutions.
6. Or equal

B. General purpose particulate filter: 30 to 40 micron element to remove larger debris, resin impregnated ribbon type filters with 40 micron thick edge filtration and drain valve.

C. General purpose pre-filter: 3 to 5 micron particulate filter, located upstream of the coalescent filter. Drain valve.

D. Coalescing Filters: Furnish with activated carbon capable of removing water and oil aerosols, with color-change dye indicating when carbon is saturated and warning light indicating when maximum pressure drop has been exceeded.

2.10 HOSE CONNECTORS

A. Manufacturers:

1. Milton Industries, Inc.
2. Pawling Corporation.

B. Hose Connectors: Corrugated stainless steel tubing with stainless steel wire braid covering and ends welded to inner tubing.

C. Working Pressure: 250 psiG minimum.

D. End Connections:

1. 2 inches and Smaller: Threaded steel pipe nipple.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify connection size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Chamfer as appropriate.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions as appropriate.

D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - INSERTS

A. Provide inserts for placement in concrete forms.

B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3.4 INSTALLATION - HANGERS AND SUPPORTS

A. Install hangers and supports in accordance with ASME B31.9.

B. Support horizontal piping to prevent sags with wall brackets/brackets approximately every 7 feet.

C. Install hangers to provide minimum 1/2 inches space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

F. Support riser piping independently of connected horizontal piping.

G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.

H. Provide copper plated hangers and supports for copper piping.

I. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.

3.5 INSTALLATION - ABOVE GROUND PIPING - COMPRESSED AIR SYSTEMS

A. Install drip connections with valves at low points of piping system.

B. Install take-off to outlets from top of main, with shut off valve after take off. Slope take-off piping to outlets.

C. Install compressed air couplings, female quick connectors, and pressure gages where outlets are indicated.

D. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.

E. Cut pipe and tubing accurately and install without springing or forcing.

F. Slope piping in direction of flow.

G. Copper Pipe with press-type Joints: Remove burrs and clean ends. Fully insert tubing into fitting and mark pipe ends to ensure full insertion into coupling or fitting. Check alignment against mark to assure tubing is fully inserted. Press joint using manufacturer's tool.

H. Install pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Refer to Section 22 05 29.

I. Except where indicated, install manual shut off valves with stem vertical and accessible for operation and maintenance.

J. Install strainers on inlet side of pressure reducing valves. Install pressure reducing valves with bypasses and isolation valves to allow maintenance without interruption of service.

3.6 INSTALLATION - EQUIPMENT

A. Install air compressor on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than compressor base on each side. Refer to Section 03 00 05 - Concrete.

B. Install air compressor unit on vibration isolators. Level and bolt in place.

C. Install air valve and drain connection on horizontal casing.

D. Install line size shut-off valve on compressor discharge.

E. Install replaceable cartridge type filter silencer for each compressor.

F. Install condensate drain piping to forebay.

G. Use factory insulated inlet and outlet connections.

3.7 FIELD QUALITY CONTROL

A. Section 01 75 00 - Checkout and Start-Up Procedures 01 77 19 - Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.9.

C. Verify for atmospheric pressure in piping systems, other than system under test.

3.8 CLEANING

A. See section 01 74 00 - Cleaning

B. Blow systems clear of free moisture and foreign matter.

END OF SECTION

DIVISION 23

HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vibration isolators.

B. Related Sections include but are not necessarily limited to:

1. Section 01 81 10 - Wind and Seismic Design Criteria: All vibration and seismic component design and installation must comply with Section 01 81 10 unless otherwise dictated by a more stringent requirement in this section.

1.2 QUALITY ASSURANCE

A. Reference Standards:

1. Air Movement and Control Association International, Inc. (AMCA):
   a. 300, Reverberant Room Method for Sound Testing of Fans.
2. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
   a. 575, Method of Measuring Machinery Sound within an Equipment Space.
3. American National Standards Institute (ANSI):
   a. S1.4, Specification for Sound Level Meters.
   b. S1.8, Reference Quantities for Acoustical Levels.
   c. S1.13, Measurement of Sound Pressure Levels in Air.
   d. S12.60, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools.
4. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
   a. 68, Laboratory Method of Testing to Determine the Sound Power in a Duct.
   b. Handbook - HVAC Applications.
5. ASTM International (ASTM):
   a. E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   b. E477, Standard Test Method for Laboratory Measurements of Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
   c. E596, Standard Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures.
6. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. HVAC Duct Construction Standards - Metal and Flexible.

B. Perform Work according to AMCA 300, ANSI S1.13, AHRI 575 standards and ASHRAE 68 recommendations.

C. Maintain 2 copies of each standard affecting Work of this Section on Site.

1.3 PRE-INSTALLATION MEETINGS

A. Section 01 42 00 - References: Requirements for pre-installation meeting.

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

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal: Requirements for submittals.

B. Product Data:

1. Submit schedule of vibration isolator type with location and load on each.
2. Submit manufacturer catalog information indicating materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.

C. Shop Drawings:

1. Indicate static and dynamic load of vibration isolators.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions indicating that maximum room sound levels are not exceeded.

F. Test and Evaluation Reports: Indicate that acoustic housings meet or exceed specified sound transmission loss values.

G. Manufacturer Instructions:

1. Submit special procedures and setting dimensions.
2. Indicate installation requirements maintaining integrity of sound isolation.

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

I. Manufacturer Reports: Certify that sound isolation installation is complete and complies with instructions.

J. Qualifications Statements:

1. Submit qualifications for manufacturer, installer, and licensed professional.
2. Submit manufacturer's approval of installer.

K. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Project Record Documents:
   a. Record actual locations of hangers including attachment points.

1.5 QUALIFICATIONS

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

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

C. Licensed Professional: Professional engineer experienced in design of specified Work and licensed in the State of Idaho.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Store materials according to manufacturer instructions.

C. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
2. Provide additional protection according to manufacturer instructions.

1.7 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

1.8 WARRANTY

A. Furnish five -year manufacturer's warranty for inertia bases.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide vibration isolation devices on motor-driven equipment over 0.5 hp, plus connected piping and ductwork.

B. Minimum Static Deflection of Isolators:

1. Basement - 20 hp and under:
   a. Under 400 rpm: 3.5 inches.
   b. 400 to 600 rpm: 3.5 inches.
   c. 600 to 800 rpm: 2.0 inches.
   d. 800 to 900 rpm: 1.0 inches.
   e. 1,100 to 1,500 rpm: 0.5 inches.
   f. Over 1,500 rpm: 0.2 inches.

C. Consider upper floor locations critical unless otherwise indicated.

D. Use concrete inertia bases for fans having static pressure greater than 3.5 inches WG, motors larger than 40 hp, and on base-mounted pumps larger than 10 hp.

2.2 VIBRATION ISOLATORS

A. Manufacturers:

1. Ace Mountings Co., Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
4. Kinetics Noise Control, Inc.
5. Mason Industries, Inc.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation.
8. The VMC Group.

B. Open Spring Isolators:

1. Spring Isolators:
   a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
   b. Code: Color-code springs based on load carrying capacity.
2. Springs:
   a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
   b. Working Deflection: Between 30 and 60% of maximum deflection.
3. Spring Mounts: Furnish leveling devices, minimum 0.25 inches thick neoprene sound pads, and zinc chromate-plated hardware.
4. Sound Pads:
   a. Size: Based on minimum deflection of 0.05 inches.
   b. As specified for neoprene pad isolators.

C. Restrained Spring Isolators:

1. Spring Isolators:

a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
b. Code: Color-code springs based on load carrying capacity.

2. Springs:
a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
b. Working Deflection: Between 30 and 60% of maximum deflection.

3. Spring Mounts: Furnish leveling devices, minimum 0.25 inches thick neoprene sound pads, and zinc chromate-plated hardware.

4. Sound Pads:
a. Size: Based on minimum deflection of 0.05 inches.

5. As specified for neoprene pad isolators.

6. Restraints: Furnish mounting frame and limit stops.

D. Closed Spring Isolators:

1. Spring Isolators:
a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
b. Code: Color-code springs based on load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.

3. Springs:
a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
b. Working Deflection: Between 30 and 60% of maximum deflection.

4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 inches.

E. Restrained Closed Spring Isolators:

1. Spring Isolators:
a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
b. Code: Color-code springs based on load carrying capacity.

2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.

3. Springs:
a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
b. Working Deflection: Between 30 and 60% of maximum deflection.

4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 inches and limit stops.

F. Spring Hangers:

1. Spring Isolators:
a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
b. Code: Color-code springs based on load carrying capacity.

2. Springs:
a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
b. Working Deflection: Between 30 and 60% of maximum deflection.

3. Housings: Incorporate neoprene isolation pad as specified for neoprene pad isolators.

4. Misalignment: Capable of 20-degree hanger rod misalignment.

G. Neoprene Pad Isolators:

1. Rubber or neoprene-waffle pads.
   a. Hardness: 30 durometer.
   b. Minimum Thickness: 1/2 inches.
   c. Maximum Loading: 40 psi.
   d. Rib Height: Not greater than 0.7 times width.
2. Configuration: 1/2 inches-thick waffle pads bonded to each side of 1/4 inches-thick steel plate.

H. Rubber Mount or Hanger:

1. Material: Molded rubber.
2. Deflection: 0.5 inches.
3. Insert: Threaded.

I. Glass-Fiber Pads: Neoprene-jacketed, pre-compressed, molded glass fiber.

J. Seismic Snubbers:

1. Description: Non-directional and double-acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Neoprene Elements:
   a. Replaceable.
   b. Minimum Thickness: 0.75 inches.
3. Capacity: Four times assigned load to mount groupings at 0.4 inches deflection.
4. Attachment Points and Fasteners: Capable of withstanding three times rated load capacity of seismic snubber.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that equipment, ductwork, and piping are installed before starting Work of this Section.

3.2 PREPARATION

A. Existing Work:

1. Provide access to existing piping and ductwork and other installations remaining active and requiring access.
2. Extend existing piping and ductwork installations using materials and methods compatible with existing electrical installations.

3.3 INSTALLATION

A. Install isolation for motor-driven equipment.

B. Bases:

1. Steel: Provide 1 inch of clearance between housekeeping pad and base.

C. Make equipment level.

D. Install spring hangers without binding.

E. Isolators:

1. Closed Spring Isolators: Adjust such that side stabilizers are clear under normal operating conditions.
2. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height; when full load is applied, adjust isolators to load to allow shim removal.

F. Provide pairs of horizontal limit springs on fans with more than 6.0 inches of static pressure and on hanger-supported, horizontally mounted axial fans.

G. Snubbers:

1. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers.
2. Provide each inertia base with minimum of four seismic snubbers located close to isolators.
3. Equipment Designated for Post-Disaster: Snub to 0.05 inches maximum clearance.
4. Other Snubbers: Provide clearance between 0.15 and 0.25 inches.

H. Support piping connections to isolated equipment resiliently for scheduled distance.

3.4 FIELD QUALITY CONTROL

A. Division 01: Requirements for inspecting and testing.

B. Inspect isolated equipment after installation and submit report, including static deflections.

C. Sound Measurements:

1. After startup, final corrections, and balancing of systems, take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations.
2. Provide 1/3 octave band measurements of artificial sound sources in areas indicated as having critical requirements.
3. Submit complete report of test results, including sound curves.

D. Testing Agency:

1. Furnish services of testing agency to take noise measurement.
2. Use meters according to ANSI S1.4.

3.5 SCHEDULES

A. Pipe Isolation Schedule:

Pipe Size (IN)	Isolated Distance from Equipment diameters
1	120
2	90 diameters
3	80 diameters
4	75 diameters
6	60 diameters
8	60 diameters
10	54 diameters
12	50 diameters
16	45 diameters
24	38 diameters

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC, DUCTWORK, PIPING AND HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Nameplates.
2. Tags.
3. Stencils.
4. Pipe markers.
5. Ceiling tacks.
6. Labels.
7. Lockout devices.

B. Related Sections include but are not necessarily limited to:

1. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Reference Standards:

1. American Society of Mechanical Engineers (ASME):
   a. A13.1, Scheme for the Identification of Piping Systems.

B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.

C. Maintain one copy of each document on site.

1.3 SUBMITTALS

A. Product Data: Submit manufacturers catalog literature for each product required.

B. Shop Drawings: Submit Identification Register including list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.

C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

D. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.4 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTUERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Nameplates, Tags and Stencils:
   a. Brady Corporation.

b. Panduit.
c. Seton by Brady Corporation.
d. National Band and Tag Company.
e. Carlton Industries, LP.

2. Ceiling tacks:
a. Marking Services, Inc.
b. R&R Identification Co.
c. Seton by Brady Corporation.

2.2 NAMEPLATES

A. Laminated two-layer phenolic or DR (high impact) acrylic with engraved black letters on light contrasting background color.
1. Thickness: Minimum 1/16 inches.
2. Color: Manufacturer standard or as specified.

B. Alternate: Laminated three-layer plastic with engraved black letters on light contrasting background color.
1. Thickness: Minimum 60 mils.
2. Color: Manufacturer standard or as specified.

2.3 TAGS

A. Nonmetallic Tags:
1. Fiberglass reinforced engraved black letters on light contrasting background color.
a. Tag size: Minimum 1-1/2 inches diameter.
b. Thickness: Minimum 100 mils.
c. Color: Manufacturer standard or as specified.

B. Metal Tags:
1. Aluminum or stainless steel disc with stamped letters and finished edges.
a. Tag size: Minimum 1-1/2 inches diameter.
b. Thickness: Minimum 0.035 inches (20 Ga).
c. Color: Black color filled into stamped text with natural metal background.

C. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.4 STENCILS

A. With clean cut symbols and letters of following size:
1. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inches high letters.
2. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1 inch high letters.
3. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches inches high letters.
4. Ductwork and Equipment: 1-3/4 inches inches high letters.

B. Stencil Paint: As specified in Section 09 96 00, colors and lettering size conforming to ASME A13.1.

2.5 SELF ADHESIVE PIPE AND DUCT MARKERS

A. Color and Lettering: Conform to ASME A13.1.

B. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
1. Thickness: Minimum 5 mils.
2. Letter Height:
a. Up to 2 inches Outside Diameter of Insulation or Pipe: 1/2 inches high letters.

b. 2-1/2 to 6 inches Outside Diameter of Insulation or Pipe: 1 inch high letters.
c. Over 6 inches Outside Diameter of Insulation or Pipe: 1-3/4 inches inches high letters.
d. Ductwork and Equipment: 1-3/4 inches inches high letters.
3. Indoor/outdoor grade.
4. Weather and UV resistant inks.
5. Permanent adhesive.

2.6 LOCKOUT DEVICES

A. Lockout Hasps:
1. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

B. Valve Lockout Devices:
1. Manufacturers:
a. Brady Corporation.
b. Master Lock Company, LLC.
2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 96 00 for stencil painting.

3.2 INSTALLATION

A. Apply stencil painting in accordance with Section 09 96 00.

B. Install identifying devices after completion of coverings and painting.

C. All identification devices to be printed by mechanical process. Hand printing is not acceptable.

D. Install nameplates with adhesive where equipment has sufficient surface area and texture.
1. Attach tags with 1/8 inches flat head screws where adhesive application is not suitable.
2. Attach tabs with plastic strap where screws should not or cannot penetrate substrate.

E. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer.

F. Install tags using corrosion resistant chain. Number tags consecutively by location.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with nameplates. Identify in-line pumps and other small devices with tags.

H. Tag single items of equipment enclosed in a housing or compartment on outside of housing.
1. Tag multiple items mounted inside a housing or compartment individually inside the housing.

I. Identify control panels and major control components outside panels with plastic nameplates.

J. Identify valves in main and branch piping with tags.

K. Tag automatic controls, instruments, and relays. Key to control schematic.

L. Identify piping, concealed or exposed, with pipe markers. Use tags on piping 3/4 inches diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.

M. Identify ductwork with nameplates. Identify service and direction. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction and change of direction and not to exceed 20 feet spacing on straight runs.

3.3 SCHEDULES

A. Ductwork:

1. Install labels on all duct in accordance with Article 3.2.
   a. Stencils or self-adhesive labels.
2. Color Coding:
   a. Black lettering on yellow backgrouond:
      1) Supply Air, Outside Air or Makeup Air.
   b. White lettering on green background:
      1) Return Air, Exhaust Air and Relief Air.

B. Above Grade Piping:

1. Install labels on all piping in accordance with Article 3.2.
   a. Stencils or self-adhesive lablels.
2. Color Coding: Per ASME A13.1.
   a. White lettering on green background:
      1) Low temperature water:
         a) Condensate Water.
   b. White lettering on blue background:
      1) Compressed Air.

C. Valves:

1. Install on all automatic valves used in temperature controls:
   a. Label per Control Drawings.
2. Install on all manual valves:
   a. Number and schedule all valves utilized on project. Coordinate numbering system with Tag Chart.
3. Utilize nonmetallic or metal tags.
   a. Use stainless steel metal tags only for corrosive areas.

D. Equipment:

1. Provide nameplate or stencil as warranted per Article 3.2.
2. Label with equipment tag as shown on the Drawings.
   a. Black lettering on white background.
3. Provide OSHA warning sign for equipment that starts automatically.
4. Label all equipment control panels located remote from unit.
5. Label all thermostats with self-adhesive markers with tag of equipment served.

END OF SECTION

SECTION 23 05 93

HVAC SYSTEMS - BALANCING AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Adjusting, balancing, and testing of all heating, ventilating and air conditioning (HVAC) systems, including the following systems:

B. Related Sections include but are not necessarily limited to:

1. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
2. Section 23 31 00 - HVAC - Ductwork.
3. Section 23 80 00 - HVAC - Equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Associated Air Balance Council (AABC):
   a. National Standards for Total System Balance.
2. American Industrial Hygiene Association (AIHA):
   a. Z9.5, Laboratory Ventilation.
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. HVAC Applications Handbook, Chapter entitled "Laboratories".
   b. HVAC Systems and Equipment Handbook, Chapter entitled "Testing, Adjusting, and Balancing".
4. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Qualifications:

1. Work of this Section to be accomplished by an independent testing and balancing firm certified by one (1) of the following:
   a. Associated Air Balance Council (AABC).
   b. National Environmental Balancing Bureau (NEBB).
   c. Other certification entity approved by Engineer.
2. The independent firm shall not be the same firm as the firm installing the HVAC equipment, nor under contract to the firm installing the equipment.

1.3 SUBMITTALS

A. Shop Drawings:

1. Certifications:
   a. Letter stating the name and qualifications of the firm proposed.
   b. Evidence that relevant subcontractors have been notified of the requirement to coordinate balance and test elements in the work with the testing and balancing firm.
2. Report forms:
   a. Procedures and forms to be used in calibrating of test instruments, balancing systems, and recording and reporting test data.

B. Informational Submittals:

1. Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.

a. Insert recorded information on report forms required by specifications and approved for use on project.
b. Additional written verification and other related information clearly identifying project, date and specifics of verification.
c. Utilize report forms similar to those shown in Section V of AABC Standard.
d. Provide forms typed and signed by the testing and balancing firm.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Secure approved Shop Drawings of all HVAC equipment.

B. Procedures and Forms:

1. Submit procedures and forms to be used in calibration of test instruments, balancing systems, and recording and reporting test data.
2. Obtain approval before beginning balancing and testing.

C. Do not begin balancing and testing until HVAC systems are complete and in full working order.

1. Place HVAC systems into full operation and continue their operation during each working day of balancing and testing.

D. Provide qualified heating and ventilating Engineer(s) to supervise and perform balancing and testing.

E. Review design Drawings, specifications, approved Shop Drawings and other related items to become thoroughly acquainted with the design of HVAC systems.

F. Check all installed systems against Contract Drawings, Specifications and Shop Drawings to see that system is installed as required.

1. Report deficiencies to the Engineer.
2. Report deficiencies to Contractor for remedial action including providing corrective measures required in the function of any part of system to complete balancing.

G. Make necessary adjustments as required to balance the systems.

3.2 FIELD QUALITY CONTROL

A. Balance and Test Air Systems:

1. Adjust equipment RPM to design requirements.
2. Report motor full load amperes.
3. Obtain design CFM at fans.
   a. Make pitot tube traverse of main supply and exhaust ducts within 5%.
4. Test and record system static pressures, suction and discharge.
5. Obtain design CFM for recirculated air.
6. Obtain design CFM outside air.
7. Test and record entering air temperatures, (DB, heating and cooling).
8. Test and record leaving air temperatures, (DB, heating and cooling).
9. Test and record leaving air temperatures, (WB, cooling).
10. Adjust dampers in supply, exhaust and return air ducts to design CFM.
11. Test diffusers, grilles, and registers as follows:
    a. Adjust to comply with design requirements within 10%.
    b. Identify location and area of each.

c. Adjust face velocity to establish required CFM.
    1) Retest after initial adjustments.
d. Adjust to minimize drafts and to ensure uniform air distribution in all areas.

12. Identify and list size, type and manufacturer of diffusers, grilles, registers, and HVAC equipment.
    a. Use manufacturer's ratings on equipment to make required calculations.
13. Adjust and assure that the operation of automatically operated dampers are as specified.
    a. Check and calibrate controls.
14. Prepare and submit reports.

END OF SECTION

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SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Instrumentation and control for HVAC systems.
2. Temperature control.
3. Ventilation control.
4. Heating control.
5. Cooling control.
6. Control wiring.
7. Panels and accessories.
8. Miscellaneous.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 23 31 00 - HVAC - Ductwork.
2. Section 23 80 00 - HVAC - Equipment.
3. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
4. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

A. See Specification Section 01 61 03.

B. Referenced Standards:

1. ASTM International (ASTM):
   a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
2. The International Society of Automation (ISA):
   a. S5.1, Instrumentation Symbols and Identification.
   b. S5.4, Standard Instrument Loop Diagrams.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL).

C. Miscellaneous:

1. Controls to be in compliance with Specification Section 26 05 00 for NEMA and NFPA 70 enclosure class requirements unless noted or specified otherwise.
2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.

1.3 SYSTEM DESCRIPTION

A. Work shall be provided as an integrated operating system.

B. Provide a complete system of automatic temperature control, thermostats, relays, valves, damper operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on Drawings, together with thermometers, gages and other accessory equipment.

1. Assemble control system with complete system of wiring and air piping to fulfill requirements of the Contract Documents.

C. Install system using competent mechanics under direct supervision of control manufacturer.

D. Controls, as set out in "Sequence of Operation," are designed to illustrate operating functions only.

1. Control sequence shall be considered supplementary to "Sequence of Operation".
2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the Contract Documents, shall be furnished and installed at no additional cost to Owner to make a complete system.

E. Sequence of Operation - General:

1. Sequence of operation indicated illustrates basic operating functions only.
2. Review Drawings and submit complete installation data, including minor details, to provide proper operation in his proposal.
3. Where an item differs from specifications, control manufacturer shall submit manufacturer's recommendations subject to Engineer's approval.

1.4 SUBMITTALS

A. Shop Drawings:

1. Wiring diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
2. Information on equipment proposed for use including corrosion protection.
3. Instrument loop diagrams and word description of loop function for each individual unit controlled including auxiliary interlocks in full compliance with ISA S5.4.
   a. Show components in system and ensure diagrams are in full compliance with ISA S5.1 (Instrumentation Symbols and Identification) and other related ISA standards.

B. Quality Control Submittals:

1. Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.
   a. Provide the above information to control manufacturer.

C. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Manufacturer's catalog numbers hereinafter are for reference to type, style, dimension, related items and to establish a standard of quality.
   a. Reference to a manufacturer's number hereinafter does not imply full compliance to these Specifications.
2. Instrumentation and control systems:
   a. Honeywell.
   b. Johnson Control Co.
   c. Or Equal

2.2 EQUIPMENT

A. Dampers:

1. Refer to Specification Section 23 31 00.

B. Damper Operators:

1. Provide operators of proper size and number to secure true throttling or two-position action as required.
2. Furnish damper operators for installation inside ductwork and attached to frame of damper, or installed outside ductwork and connected to extended shaft as required.
3. Provide operators for outside air, spring-loaded with sufficient power to assure tight closing of dampers on fan shutdown or in the fail safe position indicated by "Sequence of Controls."
4. Electric operators:
   a. Provide operators:
      1) Fully immersed in oil gear train.
      2) Enclosed in closed cast aluminum housing.
   b. As an alternate to 5.a.: Provide operators in NEMA 4X enclosure, Belimo ZS-300.
   c. Provide damper operators with integral spring return motor springs to make controls fail safe in position specified under "Sequence of Controls."
   d. Provide fully modulating operators from proportional electric controllers.
   e. Provide end switches or proportioning controllers permitting simultaneous operation or interlocking with other equipment.
   f. Provide separate electrical circuits for damper operators with no more than four operators on a circuit.
5. Coordinate with dampers provided:
   a. Provide damper operators that are rated for the required torque.
   b. If single damper operator can not meet torque requirement, provide sectional dampers to match operator torque.
6. Use of electric operators shall be limited to small dampers in those applications where it is impractical to provide pneumatic operators and are to be approved by the Engineer.
7. Ensure coordination to provide for the installation of tight closing dampers low leakage type (6 cfm per square foot at 4 inches WC pressure across damper) with compatible dampers, damper operators and related controls.
8. Refer to floor plans for additional requirements.

C. Electric Control Instruments:

1. Provide stainless steel sensing elements type thermostats with liquid filled, compensated thermal systems so that equally spaced dial graduations are possible over entire range.
   a. Make thermal systems field detachable with averaging or plain bulbs as installation conditions dictate.
   b. Provide sensing elements minimum of 60 inches in length and suitable for operation from -30 to 300 degrees F.
   c. Provide reverse acting on-off type thermostats for controlling ventilating fans.
   d. Provide multiple stage thermostats where designated in Paragraph "Sequence of Operation".
2. Provide transformers for supplying current to control equipment operating at less than 120 V and where required by manufacturer's automatic control system design capable of supplying 125% of energy requirements of equipment connected for not less than 1 hour.
   a. Enclose transformers in UL listed cabinets with conduit connections.
   b. Provide fused disconnect switches on both primary and secondary sides.

3. Provide low limit electric thermostats of two-position type with 20 feet bulb and manual reset.
    a. Shall be capable of opening thermostat circuit if any 1 foot section of bulb is subjected to a temperature below thermostat setting.
    b. Each thermostat shall have two circuits, one to shut down fan, another for alarm.
    c. Install all freeze-stats to override starter circuits regardless of position.
    d. For corrosive environments provide thermostats with stainless steel sensing elements.
        1) Ensure element is installed to sense coldest point should stratification occur.
4. Provide each thermostat with an accurate red-reading thermometer sensing temperature outside of enclosure.
5. Label thermostat with identification tag of HVAC equipment controlled using phenolic nameplate in accordance with Specification Section 23 05 53.

D. Local Temperature Control Panel:

1. Panel shall be floor or wall-mounted and be sized to accommodate electrical switches, protective devices (except electrical switches and devices furnished as an integral part of air handling unit).
2. Mount indicating controllers or receiver-controllers, three-way air valves, relay, EP and PE switches, switching relays, ammeters and other accessory items on local sub-panels set in vicinity of equipment to be served.
    a. Where two similar items of equipment, such as pumps, are installed adjacent to each other a single panel may be used to contain all instruments.
3. Fully compensated capillaries connected to instruments shall be of sufficient length to allow them to be run between equipment and placed in such a position so that they will not obstruct service of equipment or become damaged.
4. Miniature milliamp meters for electronic temperature transmission may be used.
5. Manufacture panels in one of the following manners:
    a. NEMA electrical panel boxes with windows.
    b. Install gages flush mounted in swing out panel behind window with instruments and other control items located inside enclosures behind panel.
        1) Refer to Paragraph "Corrosion Protection."
6. Mount all relays, PE switches, pressure switches, etc., on rear inside of enclosure.
    a. Tag each instrument corresponding to symbols used on control diagrams.
7. Temperatures, pressures, equipment operation, and related items shall be continuously indicated on panels.

2.3 FABRICATION

A. Corrosion Protection:

1. Protect metal parts of controls, instrumentation and related items from corrosive atmosphere by either protective coatings or select materials.
    a. Aluminum and stainless steel require no further protection.
2. Provide NEMA 4X fiberglass control enclosures with tempered glass windows and vapor tight gaskets, illustrated in Hoffman Bulletin A-50, for protection of controls from corrosive environment.
    a. Install control instruments inside enclosure and extend remote stainless steel sensing elements through enclosure wall.
    b. Provide vaportight seals for penetrations of enclosure.
3. Provide in each enclosure industrial corrosion inhibitors, Hoffman Corrosion Inhibitors, as illustrated in Hoffman's technical Bulletin HCI.
4. Protect metal accessory items such as mounting brackets and fasteners not stainless steel, fiberglass or aluminum by epoxy or phenolic coatings.

5. Protect electric motor operator with corrosion inhibitors inside enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with requirements of Specification Section 26 05 19.

B. Connect control devices to perform functions indicated and perform in required sequence.

C. Provide all controls wiring and conduits as required for all HVAC equipment for a fully functional system.

D. Use remote element temperature transmitters for points of temperature transmitters for points of temperature measurement occurring in air ducts or shafts, or in mechanical piping system.

E. Outside air temperature sensor shall be provided with sunshield and shall be mounted on north face of the building. Verify final installation requirements with manufacturer.

F. Use remote element pressure transmitters of panel-mounted pressure gages.

G. Provide conduit runs for all equipment. Coordinate requirements and routing with div. 26.

H. Provide all wiring, conduit, transformers, fusing, and all other electrical components, etc. as required for complete installation.

I. Refer to floor plans for additional requirements. Provide all control components and accessories as required for equipment to be controlled as described in the sequence of operation regardless of whether all control components are shown in the associated control diagram, plan sheets, etc.

J. Provide step down transformers as required to provide 24VAC power drop to all low voltage equipment.

K. Where continuous indication of space temperature is on local control panels, install a thermostat and a temperature transmitter side by side.

   1. Pipe continuous indication signal to a receiver on panel.
   2. A resistance element or thermocouple signal may be used with continuous indicating meter, calibrated in degrees Fahrenheit.

L. In general, locate thermostats for room control immediately inside door, above light switch, unless shown otherwise.

   1. Where light switch is in an entryway to room, locate thermostat on wall within room so it is capable of sensing true space conditions.
   2. Prior to installation, coordinate thermostat location with Engineer.

M. Mount local control panels adjacent to equipment served.

N. Where a temperature indicating gage is used at the panel, a pressure gage indicating transmitter signal is not required.

O. Provide appropriate type continuous reading indicator for each controller, transmitter and transducer.

   1. Mount in-line or tapped on controller.
   2. Mount at local control panel.

P. Gages with flexible hose terminating with hypodermic needle may be used for checking control system.

   1. Do not substitute for in-line gages.

Q. Locate panels so visual observation and adjustment can be accomplished from floor level.

END OF SECTION

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SECTION 23 31 00
HVAC - DUCTWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. HVAC ductwork and accessories.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 07 62 00 - Flashing and Sheet Metal.
2. Section 07 92 00 - Joint Sealants.
3. Section 08 90 00 - Louvers and Vents.
4. Section 01 61 03 - Equipment - Basic Requirements.
5. Section 23 09 00 - Instrumentation and Control for HVAC Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.
2. National Fire Protection Association (NFPA).
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Ducted Electric Heat Guide for Air Handling Systems.
   b. HVAC Duct Construction Standards - Metal and Flexible.
4. Underwriters Laboratory, Inc. (UL):
   a. 555, Standard for Safety Fire Damper and Ceiling Fire Damper.
   b. 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.
   c. Building Materials Directory.

B. Qualifications:

1. Fabricator: Firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three years.
2. Installers: Firm with at least five years installation experience on products similar to that required for this Project.

1.3 DEFINITIONS

A. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 61 03.
2. Efficiency ratings per ASHRAE 52 for factory built and assembled filter units.
3. Scaled ductwork drawings (1/4 inches equals 1 foot) showing duct and accessory layout and support.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
    a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Miscellaneous Submittal:
    1. Documentation of qualifications for fabricators and installers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Transverse joints (factory fabricated aluminum):
        a. Ductmate Industries, Inc.
    2. Turning vanes:
        a. Ductmate Industries, Inc.
        b. Duro Dyne.
        c. SEMCO Incorporated.
        d. Ward Industries, Inc.
    3. Flexible duct connections:
        a. Vent Fabrics.
        b. Duro Dyne.
    4. Access doors in ductwork:
        a. Vent Fabrics.
        b. American Warming.
    5. Backdraft dampers:
        a. Air Balance.
        b. Ruskin.
        c. American Warming.
    6. Grilles and registers:
        a. Anemostat.
        b. Carnes.
        c. Titus.
    7. Roof mounted gravity relief hoods:
        a. Greenheck
        b. Loren Cook
    8. Air filters:
        a. American Air Filter.
        b. Farr.
        c. Continental.
    9. Manual (volume) dampers:
        a. Air Balance.
        b. Ruskin.
        c. American Warming.
    10. Duct sealers:
        a. Durkee-Atwood.
        b. Unitec McGill.
        c. Benjamin Foster.

d. Design Polymerics.

11. Temperature control and automatic dampers:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
12. Louvers:
    a. Ruskin.
    b. Air Balance.
    c. American Warming.

2.2 COMPONENTS

A. Duct and Fittings (Metallic):

1. Materials:
    a. G90 galvanized steel:
        1) Comply with ASTM A653 and ASTM A90.
2. Fabrication (galvanized steel):
    a. Minimum Sheet Metal Thickness:
        1) Per SMACNA for 2 inches WC pressure class.
            a) Heavier gage sheet material may be used with associated reinforcement as an alternate to minimum thickness specified.
            b) Lighter gage sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.
    b. Longitudinal Seams:
        1) Pittsburgh lock seam.
        2) Continuously Welded.
    c. Transverse Seams:
        1) SMACNA T-22 or T-24 companion flange.
        2) Factory fabricated flanged duct connection system:
            a) Ductmate 25/35.
            b) Angles and Cleates: Galvanized.
            c) Snap cleats: Galvanized.
            d) Gaskets: Close cell neoprene.
            e) Bolts and screws: Stainless.
    d. Sealing:
        1) Per SMACNA for Seal Class A.

B. Duct and fittings, Manufactured:

1. Material: Galvanized steel.
2. Spiral lockseam construction.
3. Reinforcing corrugations.
4. Material thickness:
    a. Straight runs: per SMACNA.
    b. Fittings: at least two gages heavier than straight runs.
5. Fittings:
    a. All seams continuously welded.
    b. All divide flow fittings discreet and separate, i.e. no tap collars.
6. Double wall:

a. Outer wall: solid:
b. Inner wall: perforated:
c. Insulation: 1 inch fiberglass minimum.
1) Minimum ‘k-value’: 0.27 btu/ h-FT2-DEGF.
2) United McGill Acousti-k27 or approved equal

C. Supports and Hangers:
1. Materials (for galvanized duct):
a. Support angles: Galvanized or stainless steel, minimum 1-1/2 by 1-1/2 by 1/4 angle.
b. Hanger rods: Galvanized or Stainless steel.
c. Anchors: Stainless steel wedge type.
2. Fabrication: Trapeze type units.
3. Strap hangers are not allowed.

D. Turning Vanes:
1. Materials: Same as duct.
2. Fabrication:
a. Fabricate double vane units.
b. Pressure drop through elbows: Maximum 20% of velocity pressure.

E. Flexible Connections:
1. Materials: Hypalon, double coated closely woven glass fabric.
2. Fabrication: Withstand 4.5 inches water column, positive and negative pressure.

F. Access Doors:
1. Materials:
a. Inner panel, out panel and frame: Same as duct.
b. Gaskets: Closed cell neoprene.
c. Insulation: 1 pound density fiberglass.
d. Hinges: Stainless steel.
e. Latches:
1) Aluminum-zinc alloy.
2) Outside lever handle.
3) Adjustable spacer.
4) Beveled inside flange.
5) Studs:
a) Minimum 3/8 inches diameter stud for doors up to 24 inches wide x 48 inches high.
b) Minimum 1/2 inches diameter stud for doors larger than 24 x 48 inches.
2. Fabrication:
a. Provide four-side continuous gaskets.
b. Utilize continuous piano hinges.
c. Latches required:
1) 12 inches in any direction: One.
2) Up to 18 x 18 inches: Two.
3) Up to 24 x 48 inches: Two with inside handles.
4) Up to 24 x 72 inches: Three with inside handles.
5) Minimum door size: 12 x 12 inches.

G. Drain Pan:
   1. Materials: Aluminum.
   2. Fabrication: 0.080 inches.
H. Backdraft Dampers:
   1. Material:
      a. G90 galvanized steel.
      b. Blade edge seals: Extruded vinyl.
   2. Fabrication:
      a. Frame thickness: 0.125 inches minimum.
      b. Blade thickness: 0.070 inches minimum.
      c. Linkage: 1/2 inches tie bars.
      d. Bearings: Synthetic.
I. Volume Dampers and Flow Equalizers for Round Neck Diffusers:
   1. Material: Aluminum.
   2. Fabrication:
      a. Design for neck velocity: 2500 feet/MIN.
      b. Center rod operator accessible through diffuser without removing diffuser.
      c. Furnish with screws, duct collars, transitions and air pattern deflectors as required.
J. Air Grille and Register Assembly:
   1. Materials:
      a. Assembly: Steel.
      b. Gaskets: Sponge rubber.
   2. Fabrication:
      a. Supply registers: Two sets individually adjustable louvers.
      b. Exhaust and return registers: 45 degrees deflection front blades.
      c. Dampers: Key-operated opposed blade.
      d. Screws, duct collars, and transitions as required.
      e. Finish:
         1) Manufacturer's standard factory applied finish.
         2) Color: White.
K. Roof-Mounted Gravity Relief Hood:
   1. Materials:
      a. Hood: Aluminum.
      b. Screen: Expanded aluminum.
   2. Fabrication:
      a. Type indicated on Drawings.
      b. 0.080 inches thick material.
      c. Aluminum Insect Screen.
      d. Design to withstand 30 pounds/SQFT snow load and 100 mph winds.
      e. Refer to equipment schedule for additional requirements.
L. Air Filters:
   1. Materials:
      a. Holding frame: Aluminum.
   2. Fabrication:

a. Factory built and assembled unit.
b. Efficiency rating as per ASHRAE 52.
c. 2 inches thickness minimum.
d. Efficiency: 20%.
e. Air velocity: 450 fpm maximum.
f. Clean pressure drop: 0.2 inches WG maximum.
g. Size, capacity, and type: As indicated on Drawings.

M. Temperature Control, Automatic and Manually (Volume) Operated Dampers:

1. Material:
   a. Body: 6063 T5 aluminum.
   b. Seal blade edge: Extruded vinyl.
2. Fabrication:
   a. Frame thickness: 0.125 inches minimum.
   b. Provide flanged connections.
   c. Blades:
      1) Two-position damper: Opposed blade.
      2) Mixing and volume damper: Opposed blade.
      3) Airfoil shape.
      4) Maximum 6 inches width.
   d. Linkage: Concealed in frame.
   e. Axles: 1/2 inches plated steel hex.
   f. Bearings: Molded synthetic.
   g. Seals:
      1) Jamb: Flexible compression type.
   h. Control shaft: Removable, 1/2 inches diameter.
   i. Air leakage (4 feet SQ damper) at 4 inches WG pressure: 99 cfm maximum.
   j. Motors for motor operated damper: See Specification Section 23 09 00.
   k. Provide outboard support for operator linkage where damper motor is to be installed outside of duct.
   l. Provide stainless steel locking quadrants for manual (volume) dampers.
   m. Provide fold out operator mounting bracket where damper motor is to be installed on face of damper or inside duct.
   n. Finish: 215 R1 anodized.
   o. Refer to equipment schedule for additional requirements.

N. Duct sealer:

1. NFPA rating of "Non-Combustible".
2. Flame spread rating: 25 or lower, in dry condition.
3. Smoke developed rating: 50 or lower, in dry condition.
4. Resistant to water and water vapors.
5. Comply with UL 181.
6. Pressure rupture rating: 16 inches WG, minimum.

O. Louvers: See Specification Section 08 90 00.

2.3 MAINTENANCE MATERIALS

A. Extra Materials:

1. Furnish Owner with the following extra materials:

a. 2 complete filter media change(s) for each filter unit.
b. Filter media used during construction is in addition to this requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 01 61 03.

B. Metal Ductwork:

1. Install with longitudinal seams sealed for zero leakage.
   a. For welded seams, submit sample for approval by Engineer.
2. Install gaskets at each transverse joint and fasten sections together with bolts.
   a. Tighten for zero leakage.
3. Provide and install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
4. Install turning vanes in square elbows:
   a. Unsupported vane length not to exceed 48 inches.
   b. Position vanes at proper angle to meet specified pressure drop.
5. Install flexible connections at fans:
   a. Locate as close as possible to fan.
   b. Allow 1 inch of slack to prevent vibration transmission.
   c. Install thrust restraints across connectors.
6. Install access doors where indicated on Drawings and as required by code.
7. Provide all required duct supports. Support ductwork per SMANCA and building code requirements. Provide seismic bracings as required per building code and SMACNA.
8. Coordinate routing of ductwork with all trades before starting work.

C. Drain Pans:

1. Install at fan coil cooling coils, control valves above finished ceilings and at other sources of moisture.
2. Install metal tubing at drain and terminate above floor drain, equipment drain and as shown on Drawings.

D. Dampers:

1. Install where indicated on Drawings of sizes shown.

E. Air Grille and Register Assemblies:

1. Install where shown on Drawings of size and capacities scheduled on Drawings.
2. Install prime painted grilles and registers in areas where duct work is concealed.
   a. Field paint to match adjacent surface finish.

F. Roof-mounted Relief Hoods: Install where shown on Drawings.

G. Air Filters:

1. Install where shown on Drawings of size and capacity scheduled on Drawings.
2. Do not operate equipment during construction without filters.

END OF SECTION

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SECTION 23 34 00
HVAC - FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 23 05 93 - HVAC Systems - Balancing and Testing.
3. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
4. Section 23 31 00 - HVAC - Ductwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Air Movement and Control Association (AMCA).
   a. AMCA Publication 203 "Field Performance Measurement of Fan Systems".
   b. ANSI/AMCA 210 "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating".
2. Air Conditioning and Refrigeration Institute (ARI).
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
   b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
   c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
4. Canadian Standards Association (CSA).
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
7. National Roofing Contractors Association (NRCA).
8. Underwriters Laboratories, Inc. (UL):
   a. 507, Standard for Electric Fans.

B. Miscellaneous:

1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Wiring diagrams.
   d. Control diagrams.

e. Manufacturer's catalog cuts and technical data.
f. Corrosion-protection information.
g. Fan curves.
h. Sound data.
i. Vibration isolation.
j. Performance data on all equipment.

2. Certifications:
a. Provide certification of thickness of corrosion-protection coating.
b. Fan systems have been tested in accordance with AMCA Standard 210 or 260, and are licensed to bear the AMCA Certified Ratings Seal.

B. Factory Performance test for any fan having a flow rate greater than 1,000 cfm and/or a total static pressure rating equal to or greater than 1.5 inches WC.

1. Pursuant to AMCA Publication 203 or 210 with no plus tolerances on Power and no minus tolerances on flow or pressure.

C. Contract Closeout Information:

1. Operation and Maintenance Data:
a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Vibration isolation assemblies:
a. Mason.
b. Vibration Mounting and Controls Co.
c. Vibro-Acoustics.

2. Corrosion-protective coatings:
a. Heresite and Chemical Co.; "Heresite."
b. Aero-Marine Engineering, Inc.

3. In-line centrifugal fans:
a. Loren Cook.
b. Greenheck.

4. Roof-mounted centrifugal exhaust fans:
a. Loren Cook.
b. Greenheck.
c. PennBarry Ventilator Co., Inc.

2.2 GENERAL

A. All Manufactured Units:

1. Comply with Specification Section 01 61 03.
2. Factory wired and assembled.
3. Use fasteners made of same material as unit.
4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.

1. Type:
   a. Corrosion-resistant materials:
      1) Aluminum.
      2) Stainless steel.
   b. Corrosion-resistant coating:
      1) Epoxy-based coating.
      2) 3 mil minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 degrees F.
      3) 5 mil baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 degrees F.
      4) Factory applied.
      5) Provide factory certification of application.

2.3 MANUFACTURED UNITS

A. In-Line Centrifugal Fans:

1. AMCA certified Class I, II, or III.
2. Non-overloading horsepower capability.
3. Materials:
   a. Wheel, impeller hub and blades: Aluminum or stainless steel.
   b. Housing, innertube and belt well: Aluminum or stainless steel.
   c. Inlet cone: Aluminum or stainless steel.
   d. Driver shaft: Solid stainless steel.
4. Airfoil design blades.
   a. All welded construction.
5. All welded housing, innertube and belt well.
6. Innertube construction:
   a. Isolates bearings and drive from airstream.
   b. Removable end covers.
7. Bearings:
   a. Cast iron pillow blocks.
   b. Concentric bearing locking collar for drive shafts 1 inch and larger.
      1) SKF "ConCentra."
      2) Dodge "D Lock."
   c. Regreaseable.
   d. 200,000 hour average life.
8. Motor:
   a. See Specification Section 01 61 03.
   b. Belt Drive Units:
      1) Driver and driven sheaves:
         a) Keyed hub type.
         b) Drive sheaves: Fixed pitch diameter.
         c) Driver:
            (1) Shipped with variable pitch diameter sheave.
            (2) Fixed pitch diameter size based on approved test and balance reports.
         d) V-belt drives sized for 150% motor horsepower.

2) Automatic drive belt tensioner.
c. Adjustable motor base.
9. Flanged inlet and outlet.
10. Accessories:
a. Weatherproof, louvered motor enclosure for exterior installation.
b. Internal inlet damper with external control linkage.
c. Cam type access door.
d. Ceramic felt shaft seal.
e. Extended grease links and fittings.
11. Size and capacity as scheduled on Drawings.
12. Refer to equipment schedule for additional requirements.

B. Roof-Mounted Centrifugal Exhaust Fans:
1. AMCA certified.
2. Non-overloading horsepower capability.
3. Materials:
a. Top cap: Spun aluminum.
b. Wheel and inlet shroud: Aluminum.
c. Baffle: Aluminum.
d. Base: One-piece aluminum.
e. Drive assembly supports: Steel.
f. Drive shaft: Solid stainless steel.
g. Minimum 10 GA motor mounting plate.
4. Backward inclined blades.
5. Tapered inlet shroud.
6. Statically and dynamically balanced wheel.
7. Bearings:
a. Cast iron pillow blocks.
b. Concentric bearing locking collar for drive shafts 1 inch and larger.
1) SKF "ConCentra."
2) Dodge "D Lock."
c. Regreaseable.
d. 200,000 hour average life.
e. 5-to-1 load capability to actual load ratio.
8. Weathertight compartment for motor and drives.
a. Separated from airstream.
9. Motor:
a. See Specification Section 01 61 03.
b. Belt Drive Units:
1) Driver and driven sheaves:
a) Keyed hub type.
b) Drive sheaves: Fixed pitch diameter.
c) Driver:
(1) Shipped with variable pitch diameter sheave.
(2) Fixed pitch diameter size based on approved test and balance reports.
d) V-belt drives sized for 150% motor horsepower.
2) Automatic drive belt tensioner.

c. Vibration isolated drive assembly.

10. Accessories:
    a. Prefabricated insulated aluminum roof curb.
    b. Backdraft damper: See Specification Section 23 31 00.
    c. Bird screen.
    d. Extended grease lines and fittings.
    e. Refer to equipment schedule for additional requirements.
11. Size and capacity as scheduled on Drawings.
12. Coordinate exact fan roof opening requirements, location of roof openings, etc. with structural and architectural before start of work.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

C. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings lubricated and fan has been test run under observation.

D. Contractor is responsible to Install and support equipment per manufacturer's installation instructions and in compliance with all local codes.

E. Contractor is responsible to provide all required equipment supports.

3.2 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93.

END OF SECTION

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SECTION 23 80 00
HVAC - EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 23 05 93 - HVAC Systems - Balancing and Testing.
3. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
4. Section 23 31 00 - HVAC - Ductwork.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Air Movement and Control Association (AMCA).
2. Air Conditioning and Refrigeration Institute (ARI).
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
   a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
   b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
   c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
4. Canadian Standards Association (CSA).
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
7. National Roofing Contractors Association (NRCA).
8. Underwriters Laboratories, Inc. (UL):
   a. 507, Standard for Electric Fans.

B. Miscellaneous:

1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

A. Shop Drawings:

1. Fabrication and/or layout drawings.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Wiring diagrams.
   d. Control diagrams.
   e. Manufacturer's catalog cuts and technical data.

f. Corrosion-protection information.
g. Fan curves.
h. Sound data.
i. Vibration isolation.
j. Control description.
k. Performance data on all equipment.

3. Certifications:
   a. Provide certification of thickness of corrosion-protection coating.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Vibration isolation assemblies:
      a. Mason.
      b. Vibration Mounting and Controls Co.
      c. Vibro-Acoustics.
   2. Corrosion-protective coatings:
      a. Heresite and Chemical Co.; "Heresite."
      b. Aero-Marine Engineering, Inc.
      c. Luvata ElectroFin.
   3. Cooling coils - direct expansion:
      a. Carrier.
      b. Daikin Applied.
      c. AAON.
   4. Unit heater - electric:
      a. Brasch.
      b. Chromalox.
      c. QMark.
      d. Reznor
   5. Packaged roof-top AC units:
      a. AAON.
      b. Carrier.
      c. Trane

2.2 GENERAL

A. All Manufactured Units:
   1. Comply with Specification Section 01 61 03.
   2. Factory wired and assembled.
   3. Use fasteners made of same material as unit.
   4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
      a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. All manufactured units shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.

1. Type:
   a. Corrosion-resistant materials:
      1) Aluminum.
      2) Stainless steel.
   b. Corrosion-resistant coating:
      1) Phenolic-based coating:
         a) 3 mil minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 degrees F.
         b) 5 mil baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 degrees F.
         c) Factory applied.
         d) Provide factory certification of application.

2.3 MANUFACTURED UNITS

A. Equipment Coils:

1. Cooling coils - direct expansion:
   a. ARI certified.
   b. Material:
      1) Aluminum.
      2) Copper with aluminum fins for use in administration units only.
   c. Fin spacing: Minimum 80 fins per foot.
   d. Minimum standard operating limit: 250 psi.
   e. Size and capacity as scheduled.

B. Unit Heater - Electric:

1. Type: As identified in the equipment schedule.
2. UL listed for non-rated areas.
3. Material:
   a. Cabinet: 18 GA steel.
   b. Heating elements: Copper-clad steel.
4. Fan motors:
   a. See Specification Section 01 61 03.
   b. Built-in automatic reset overload protection.
5. Dynamically balanced fan.
6. Built-in automatic reset cutout protection.
7. Accessories:
   a. Mounting bracket.
   b. 40 to 90 degrees F, 5 degrees F differential internal thermostat.
   c. Refer to equipment schedule for additional requirements.
8. Electrical, fan motor, and airflow data as scheduled on Drawings.

C. Packaged Roof-Top AC Units:

1. UL listed.
2. Designed for outdoor application.
3. Unit construction:
   a. Fabricate unit with 14 GA channel posts and panels secured with mechanical fasteners.

1) Seal all panels, access doors, and ship sections with permanently applied bulb-type gasket.
2) Loose shipped gasketing is not allowed.

b. Construct panels and access doors as a 2 inches nominal thick; thermal broke double wall assembly, injected with foam insulation for an R-value of not less than R-13.
1) Construct the outer panel and inner liner of G90 galvanized steel.

c. Panel deflection:
1) Do not exceed L/240 ratio at 125% of design static pressure, maximum positive or negative 8 inches of static pressure.
2) Measure deflection at the midpoint of the panel height.

d. Casing leakage rate: Do not exceed 0.5 cfm per square foot of cabinet area at 6 inches of negative static pressure or 5 inches of positive static pressure.

e. Module to module assembly:
1) Provide an overlapping, full perimeter, insulated, internal splice joint sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.

f. Entire unit:
1) Provide with a 4 inches full perimeter base rail for structural rigidity and condensate trapping.
2) Overhang the roof curb for positive water runoff and seat on the roof curb gasket to provide positive weather tight seal.
3) Provide lifting lugs on unit base and with fork lift slots in unit base.

g. Access doors:
1) Flush mounted to cabinetry, with minimum of two, 6 inches long stainless steel piano-type hinges, latch and full size (4.5 inches minimum) handle assembly (provide inspection window for fan section).
2) Swing door outward for unit sections under negative pressure (inward for unit sections under positive pressure).
3) Provide a secondary latch to relieve pressure and prevent injury upon access doors limited from swinging inward (such as side access filter sections) on positive pressure sections, shall have.

h. Construct drain pans from microbial resistant coated galvanized steel or stainless steel with cross break and double sloping pitch to drain connection.
1) Provide drain pans under cooling coil section.
2) Drain connection centerline: A minimum of 3 IN above the base rail to aid in proper condensate trapping.
3) Drain connections that protrude from the base rail are not acceptable.
4) There must be a full 2 inches thickness of insulation under drain pan.

4. Refrigerant condensing section:

a. Compressors:
1) Inverter scroll type, with five year non-prorated warranty.
2) Suction and discharge service valves.
3) Thermal overload protection.

b. Refrigeration circuit:
1) Sight glass.
2) Filter dryer.
3) Manual shut-off valve.
4) High pressure relief valve.

5) Refrigerant bypass valve between suction and discharge lines for low head pressure starting.

c. Compressor isolators.

d. Condenser coils:

1) Nominal 3/8 inches OD seamless copper mechanically bonded to corrugated aluminum fins.

2) Factory leak tested at 315 psiG under water.

e. Condenser fans:

1) Direct drive: See Specification Section 01 61 03.

2) Propeller-type.

f. Condenser fan motors:

1) Heavy duty, inherently protected, non-reversing.

2) Permanently lubricated bearings.

3) Integral rain shield.

5. Cooling coil section:

a. Evaporator coils: See paragraph(s) in Article 2.3, Equipment Coils.

b. Evaporator coil circuiting:

1) Adjustable thermal expansion valve per circuit with external equalizer.

2) Combination row/split face circuiting.

c. Drain pan:

1) Mastic-coated:

2) Threaded drain connections.

6. Supply fan section:

a. Supply fans:

1) Double-width, double-inlet centrifugal type.

2) Forward curved.

3) Solid steel shafts.

4) 200,000 hour relubricative ball-bearings.

b. Fan motors:

1) See Specification Section 01 61 03.

2) Adjustable base.

c. Driver and driven sheaves:

1) Keyed hub type.

2) Drive sheaves: Fixed pitch diameter.

3) Driver:

a) Shipped with variable pitch diameter sheave.

b) Fixed pitch diameter size based on approved test and balance reports.

4) V-belt drives sized for 150% motor horsepower.

d. Isolated fan assembly.

7. Filter section:

a. Filters: See Specification Section 23 31 00.

b. Access doors for filter removal.

8. Outdoor air section:

a. Designed to form a plenum.

b. 0 to 100% outside air with economizer control.

c. Horizontal louvers with rain lip and birdscreen.

d. Floor sloped for water drainage.
e. Dampers:
    1) Sized to handle 100% supply air volume.
    2) Arranged vertically to encourage mixing of return and outside airstreams.
    3) Airfoil type.
    4) Fully gasketed and side sealed.
f. Adjustable potentiometer.
g. Adjustable enthalpy control outside of airstream.
h. Modulating spring return type damper motor.

9. Electrical:
    a. Factory wired in accordance with NFPA 70 requirements.
    b. 115 V control circuit transformer.
    c. 115 V receptacle.
    d. System service switch.
    e. Control circuit fuse.
    f. Individually fused supply and return fan motors, compressor and condenser fan motor branch circuits.
    g. Weatherproof control panel with dead-front cover over main power controls.
    h. Disconnect switch.
10. Size and capacity as scheduled on Drawings.
11. Refer to equipment schedule for additional requirements.
12. Coordinate the exact size of the concrete curb required with structural.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

C. Install and mount equipment per manufacturer’s installation instructions. Support equipment per building code and manufacturer's installation instructions.

D. Coordinate the routing of ductwork and unit placement with all trades before starting work.

3.2 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93.

3.3 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

DIVISION 26

ELECTRICAL

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SECTION 26 05 00
ELECTRICAL - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 03 - Concrete.
2. Section 01 61 03 - Equipment - Basic Requirements.
3. Section 03 15 19 - Anchorage to Concrete.
4. Section 10 14 00 - Identification Devices.
5. Section 26 20 00 - Electrical Distribution System.
6. Section 26 32 15 – Engine Generator – Liquid Propane Gas (LPG).

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association (AA):
   a. ADM, Aluminum Design Manual.
2. American Institute of Steel Construction (AISC):
   a. Steel Construction Manual.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C2, National Electrical Safety Code (NESC).
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
7. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ICS 6, Industrial Control and Systems Enclosures.
8. Underwriters Laboratories, Inc. (UL).
   a. 94, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

B. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.

1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.
2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.

1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
2. General requirements:
   a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
   b. Include data sheets that include manufacturer's name and product model number.
      1) Clearly identify which item on data sheets is being submitted.
      2) Clearly identify all optional accessories provided.
   c. Acknowledgement that products are NRTL listed or are constructed utilizing NRTL recognized components.
   d. Manufacturer's delivery, storage, handling and installation instructions.
   e. Product installation details.
   f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
   g. See individual specification sections for any additional requirements.
3. Fabrication and/or layout drawings:
   a. Concrete and reinforcing steel, per Division 03 requirements.
   b. Feeder Routing
   c. Provide a conductor identification schedule for all power, control, communication and protective circuits.
      1) Schedule to include the following information:
         a) Conductor identification number.
         b) Conductor size.
         c) Number of conductors.
         d) Type of conductor.
         e) Size of conductor.
         f) Size of conductor usage descriptions.
         g) Conductor run (to and from).
         h) Conduit size and type.

d. Provide circuit schedules for all power, control, communication, and protective circuits.
   1) Include a detailed description, list of individual loads per circuit and a total estimated load per circuit.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 78 23 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content process of Operation and Maintenance Manuals.

C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
   1. Outdoor areas:
      a. Wet.
      b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
   2. Indoor areas:
      a. Dry.
      b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
   1. Manufacturers:
      a. Modular strut:
         1) Unistrut Building Systems.
         2) B-Line by Eaton.
         3) Globe Strut.
         4) Superstrut by Thomas & Betts.
   2. Material requirements:
      a. Modular strut:
         1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
         2) Stainless steel: AISI Type 316.
      b. Structural members (e.g., I beams, L and C channels):
         1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
         2) Aluminum: AA Type 6061-T6 or 6063-T6.
      c. Mounting plates:

1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
2) Aluminum: AA Type 6063-T6.

d. Mounting hardware:
1) Galvanized steel.
2) Stainless steel.

e. Anchorage per Specification Section 03 15 19.

f. Concrete and reinforcing steel: See Division 03 specifications.

B. Equipment pads (interior and exterior):

1. Concrete and reinforcing steel: See Division 03 specifications.

C. Field touch-up of galvanized surfaces.

1. Zinc-rich primer.
a. One coat, 3.0 mils, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:

1. NFPA 70.
2. IEEE C2.
3. The manufacturer's instructions.

C. In general, conduit routing is not shown on the Drawings.

1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:

1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 inches from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:

1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
    a. Light switch (to center): 46 inches.
    b. Receptacle in architecturally finished areas (to center): 18 inches.
    c. Receptacle on exterior wall of building (to center): 18 inches.
    d. Receptacle in non-architecturally finished areas (to center): 18 inches.
    e. Safety switch (to center of operating handle): 54 inches.
    f. Separately mounted motor starter (to center of operating handle): 54 inches.
    g. Pushbutton or selector switch control station (to center): 46 inches.
    h. Panelboard (to top): 72 inches.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
    1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 6 inches in equipment location with the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:
    1. Dry areas:
        a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
        b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
    2. Wet areas:
        a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
        b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
    3. Corrosive areas:
        a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
    1. See Specification Section 03 15 19.
    2. Do not cut, or weld to building structural members.
    3. Do not mount safety switches or other equipment to equipment enclosures.

M. Provide non-metallic corrosion resistant spacers to maintain 1/4 inches separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas , etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Identify electrical equipment and components in accordance with Specification Section 10 14 00.

R. Provide field markings and/or documentation of available short-circuit current (available fault current) and related information for equipment as required by the NFPA 70 and other applicable codes.

S. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.

1. Determine the SCCR rating by one of the following methods:
   a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
   b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
   c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

3.2 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.

1. See Specification Section 01 73 20 for openings and penetrations in structures.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning:

1. See Specification Section 01 74 00.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.

1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair surfaces which will be inaccessible after installation prior to installation.
4. See Specification Section 26 20 00 for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

3.3 DEMONSTRATION

A. Demonstrate equipment in accordance with Specification Section 01 75 00.

END OF SECTION

SECTION 26 05 09
MOTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Induction motors.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 26 20 00 – Electrical Distribution System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Bearing Manufacturers Association (ABMA).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 841, Standard for Petroleum and Chemical Industry - Premium-Efficiency, Severe-Duty, Totally-Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up To and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).

B. Miscellaneous:

1. When motors are furnished with driven equipment, the driven equipment supplier shall be responsible for assembling the motor and driven equipment as a complete unit, correctly aligned and coupled with the coupling or sheave specified on the driven equipment data sheet, and designing for vibration, special, or unbalanced forces resulting from equipment operation.
   a. See Specification Section 01 61 03 for requirements.
2. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and ensure their compatibility.

1.3 DEFINITIONS

A. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

B. Abbreviations:

1. DPFG - Dripproof Fully Guarded.
2. ODP - Open Dripproof.
3. RTD - Resistance Temperature Detector.
4. TEFC - Totally Enclosed Fan Cooled.
5. TENV - Totally Enclosed Non-ventilated.
6. WP-I - Weather Protected Type I.
7. WP-II - Weather Protected Type II.
8. Motor controllers:
   a. FVNR - Full Voltage Non-Reversing.

b. RVAT - Reduced Voltage Autotransformer.
c. RVPR - Reduced Voltage Primary Reactor.
d. RVSS - Reduced Voltage Solid State.
e. VFD - Variable Frequency Drive.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data:
   a. Identify each motor by driven machine identification.
   b. Motor manufacturer and model number.
   c. Complete motor nameplate data.
   d. Weight.
   e. NEMA design type.
   f. Enclosure type.
   g. Frame size.
   h. Winding insulation class and temperature rise.
   i. Starts per hour.
   j. Performance data:
      1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 60 HP.
      2) Time-current plots with acceleration verses current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 60 HP.
      3) Guaranteed minimum efficiencies at 100%, 75% and 50% of full load.
      4) Guaranteed minimum power factor at 100%, 75% and 50% of full load.
      5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.
      6) Starting, full load and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.
   k. Bearing data and lubrication system.
   l. Thermal protection system including recommended alarm and trip settings for winding and bearing RTDs.
   m. Recommended size of power factor correction capacitors to improve power factor to 0.95 lagging when operated at full load.
2. Fabrication and/or layout drawings:
   a. Dimensioned outline Drawing.
   b. Connection diagrams including accessories (strip heaters, thermal protection, etc.).
3. Certifications:
   a. When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
4. Test reports:
   a. Motor test reports for all testing required in this Specification Section.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Installation instructions.

3. Operation and maintenance instructions.
4. Recommended spare parts list.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment during shipment, handling, and storage by suitable boxes, crates, or other complete enclosures.

1. Protect equipment from exposure to elements and keep thoroughly dry.

B. Protect painted surfaces against impact, abrasion, discoloration, and other damage.

1. Repaint damaged painted surfaces to satisfaction of Engineer.

C. Store all motors in a clean and dry indoor location until final installation.

D. Where space heaters are provided in motors, provide temporary electrical power and operate heaters during storage and after motors are installed in permanent location until equipment is placed in service.

E. For storage longer than one month, see manufacturer's storage instructions.

1.6 SITE CONDITIONS

A. Ambient air temperature: 40-110 DEGF.

B. Altitude: 4500 feet above sea level.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. ABB Baldor-Reliance.
2. General Electric.
3. Hyundai Heavy Industries.
4. Marathon.
5. Siemens.
6. TECO-Westinghouse Motor Company.
7. Toshiba U.S.
8. Toshiba Mitsubishi-Electric Industrial Systems Corporation (TMEIC).
9. U.S. Motors by Nidec Motor Corporation.
10. WEG.

2.2 EQUIPMENT

A. General Requirements:

1. Standards: NEMA MG 1.
2. Identify each motor by the driven machine identification.
3. An embossed or engraved stainless steel nameplate, with the required NFPA 70 and NEMA data, to be permanently attached to the motor.
4. Maximum motor loading shall not exceed motor nameplate horsepower rating, exclusive of service factor.
5. All motors shall be sized to carry continuously all loads, which may be imposed through their full range of operation.
6. Altitude: For applications above 3300 feet, motors to be specifically designed and certified for operation at the specified altitude.
7. NEMA MG 1, Design B (unless otherwise required), constant speed squirrel-cage induction type having normal starting torque with low starting current.

8. Suitable for the starting method indicated (e.g., full voltage, autotransformer, solid state reduced voltage, VFD, etc.).
9. Where frequent starting occurs, design for frequent starting duty equivalent to duty service required by driven equipment.
10. Lifting devices: Motors weighing 265 pounds or more shall have suitable lifting eyes for installation and removal.
11. Grounding:
    a. Lug suitable to terminate ground wire in terminal box, sized as indicated on the Drawings.
    b. Frame ground pad on medium voltage induction motors.
12. Stator windings: Copper.
13. Rotor cage: Aluminum or copper.
14. Motor leads shall be non-wicking with permanent identifiers.
15. Totally enclosed motor to have one-way breather drains.
16. Efficiency:
    a. Meet NEMA MG 1 (NEMA Premium) efficiencies.
    b. If motor type, horsepower or speed is not included in the NEMA requirements for NEMA Premium, provide manufacturers "premium energy efficient" design.
17. Power factor:
    a. Minimum of 80% lagging at full load, except on motors with speed slower than 900 rpm.
    b. Power factor correction capacitors to be utilized when indicated on the Drawings.
18. Service factor:
    a. 100 hp or less: 1.15.
    b. Greater than 100 hp: 1.0 unless noted otherwise.
    c. Inverter duty: 1.0.
19. Standards: NEMA MG 1.

2.3 FRACTIONAL INDUCTION MOTORS

A. Electrical Ratings:
    1. Appropriate for the voltage system indicated, single phase, 60 Hz.
    2. Dual voltage rated motors (e.g., 115/230 V) are acceptable, provided all leads are brought out to the terminal box and permanently marked.

B. Enclosure: TENV or TEFC, rolled steel enclosure permitted.

C. Bearings: Lubricated-for-Life ball bearings.

D. Insulation: Class F insulation with temperature rise not to exceed the insulation class.

E. Thermal Protection: Integral manual or automatic reset thermal protector.

2.4 INDUCTION MOTORS, 600 VOLT AND LESS

A. Horizontal Shaft:
    1. Electrical rating:
        a. Appropriate for the voltage system indicated, 3 PH, 60 Hz.
        b. Dual voltage rated motors (e.g., 230/460 V) are acceptable, provided all leads are brought out to the terminal box and permanently marked.
    2. Enclosure:
        a. Cast iron (exception: fan covers can be steel).
        b. Type: DPFG, TEFC, WP-I or WP-II as indicated in the schedule.
    3. Terminal box:

a. Gasketed.
b. Diagonally split.
c. Field adjustable in 90 degrees increments.
d. Oversized to accept the required conductors and conduits.
e. Located on “F1” side unless specifically indicated to be on the “F2” side.
f. Separate terminal box with terminal blocks for winding thermal protection devices (RTD and thermocouples).

4. Bearings:
   a. 5 hp and less: Lubricated-for-Life ball bearings.
   b. Greater than 5 hp:
      1) Relubricatable.
      2) Antifriction.
      3) Minimum rated ABMA L-10 life of 10 years or 100,000 hours.
5. Insulation:
   a. Class F insulation with Class B temperature rise.
   b. Double dipped and baked with non-hydroscopic varnish or epoxy.
6. Accessories: See the ACCESSORIES Article in PART 2 and the SCHEDULES Article in PART 3.
7. Modifications:
   a. Inverter duty:
      1) At a minimum, applied to motors connected to a VFD.
      2) Windings insulated for 1600 peak volts and voltage rise times of 0.1 microseconds.
      3) Nameplate identification of meeting NEMA MG 1 Part 31 requirements.
      4) Have the following minimum turndown ratio without the use of a blower to provide continuous supply of cooling air over the motor.
         a) Variable torque: 10:1.
         b) Constant torque: 6:1.
      5) Insulated drive end bearing on all motors.
      6) Motors 100 hp and larger, insulted non-drive and bearings.
      7) Shaft grounding ring on all motors:
         a) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
         b) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
   b. Severe duty:
      1) Standard: IEEE 841.
      2) All cast iron enclosure.
      3) Terminal box threaded and gasketed.
      4) Internal and external epoxy base paint system.
      5) Drain and breather.

B. Vertical Solid Shaft:
   1. Electrical rating:
      a. Appropriate for the voltage system indicated, 3 PH, 60 Hz.
   2. Enclosure:
      a. Cast iron.
      b. Type: WP-I.
   3. Terminal box:

a. Gasketed.
b. Diagonally split.
c. Oversized to accept the required conductors and conduits.
d. Separate terminal box with terminal blocks for winding thermal protection devices.

4. Bearings (Solid Shaft):
   a. Relubricatable.
   b. Antifriction.
   c. Minimum rated AMBA L-10 life of 10 years or 100,000 hours.
5. Non-reverse ratchets.
6. Insulation:
   a. Class F insulation with Class B temperature rise.
   b. Two cycles of vacuum pressure impregnated (VPI) with epoxy resin.
7. Accessories: See the ACCESSORIES Article in PART 2 and the SCHEDULES Article in PART 3.
8. Modifications:
   a. Inverter duty:
      1) At a minimum, applied to motors connected to a VFD.
      2) Windings insulated for 1600 peak volts and voltage rise times of 0.1 microseconds.
      3) Nameplate identification of meeting NEMA MG 1 Part 31 requirements.
      4) Have the following minimum turndown ratio without the use of a blower to provide continuous supply of cooling air over the motor.
         a) Variable torque: 10:1.
         b) Constant torque: 6:1.
      5) Insulated drive end bearing on all motors.
      6) Motors 100 hp and larger the non-drive end shall have an insulted bearing carrier.
      7) Shaft grounding ring on all motors:
         a) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
         b) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.

2.5 ACCESSORIES

A. Thermal Protection:
   1. RTDs: Motors over 200 Hp
      a. One winding RTDs per phase imbedded in windings.
      b. One bearing RTD per bearing.
      c. 100 OHM platinum.

B. Space Heaters:
   1. Silicone rubber strip type, 120 V rated.
   2. Provided on:
      a. All motors 10 hp and larger mounted outdoors.
      b. Indoor motors in humid environments as indicated.

C. Vibration Detector:
   1. Seismic Type Vibration Switch:
      a. For motors over 250 hp with sleeve bearings, in continuous service, radial shaft displacement vibration switch shall be installed by the motor manufacturer.

b. Robertshaw Model 366 NEMA 4 vibration switch, or approved equal shall be installed on the upper bracket.

c. All elements shall be fully protected in sealed weatherproof conduit and housings.

2.6 SOURCE QUALITY CONTROL

A. Test motors in accordance with NEMA, IEEE and manufacturer procedures.

1. The test shall include but not necessarily be limited to the following:

a. Routine test:

1) No-load current and speed at rated voltage and frequency.
2) Locked rotor current.
3) Winding resistance.
4) Vibration check.
5) High potential.

b. Complete test (in addition to the routine tests):

1) Rated load temperature rise.
2) Winding resistance.
3) Slip test, measured in percent slip.
4) Locked rotor amperes (3 PH, full voltage).
5) Locked rotor torque.
6) Breakdown torque.
7) Efficiencies tabulated at 100, 75, and 50% of full load.
8) Power factor tabulated at 100, 75, and 50% of full load.

B. Motors to be tested:

1. As indicated in the schedule.
2. All motors, at a minimum, to receive a routine test.

C. The Owner reserves the right to select and have tested any motor included within the project.

1. If motor passes testing requirements, the Owner shall be responsible for any shipping and testing costs incurred.
2. Costs shall be determined by current freight rates and manufacturer's published rates at the time of the test.
3. If motor fails test, Supplier shall be responsible for all costs incurred.
4. If two successive motors fail the test, the Owner has the right to reject any or all motors from that manufacturer.
5. The Owner also reserves the right to witness any routine or complete tests at the Owner's expense.
6. Notify the Owner a minimum of 14 days in advance of the testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Ground all motors in accordance with Specification Section 26 20 00.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 01 61 03.

END OF SECTION

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SECTION 26 05 19

WIRE AND CABLE - 600 VOLT AND BELOW

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
   a. Building wire.
   b. Power cable.
   c. Control cable.
   d. Shielded VFD cable.
   e. Instrumentation cable.
   f. Fiber optic cable.
   g. Wire connectors.
   h. Insulating tape.
   i. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 26 05 00 - Electrical - Basic Requirements.
2. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Insulated Cable Engineers Association (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
2. National Electrical Manufacturers Association (NEMA):
   a. ICS 4, Industrial Control and Systems: Terminal Blocks.
3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
   a. WC 57/S-73-532, Standard for Control Cables.
   b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
5. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
   a. 568, Commercial Building Telecommunications Cabling Standard.
6. Underwriters Laboratories, Inc. (UL):
   a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
   b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
   c. 467, Standard for Safety Grounding and Bonding Equipment.
   d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
   e. 486C, Standard for Safety Splicing Wire Connections.
   f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

i. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:

1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. The following are specific types of instrumentation cables:
   a. Analog signal cable:
      1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 VDC) signals, using No. 16 AWG and smaller conductors.
      2) Commonly used types are defined in the following:
         a) TSP: Twisted shielded pair.
         b) TST: Twisted shielded triad.
   b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
      1) Wire connectors.
      2) Insulating tape.
      3) Cable lubricant.
   b. See Specification Section 26 05 00 for additional requirements.
2. Miscellaneous:
   a. Cable pulling plan and data.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Building wire, power and control cable:
   a. Aetna Insulated Wire.
   b. Alphawire.
   c. Cerrowire.
   d. Encore Wire Corporation.
   e. General Cable.
   f. Okonite Company.
   g. Southwire Company.
2. Shielded VFD cable:
   a. Belden Inc.
   b. General Cable.
   c. Okonite Company.
   d. Olfex Wire and Cable, Inc.
   e. Priority Wire and Cable (Prysmian).
   f. Rockbestos-Surprenant Cable Corp.
   g. Southwire Company.
3. Instrumentation cable:
   a. Analog cable:
      1) Alphawire.
      2) Belden Inc.
      3) General Cable.
4. Wire connectors:
   a. Burndy Corporation.
   b. Buchanan.
   c. Ideal.
   d. Ilsco.
   e. 3M Co.
   f. Teledyne Penn Union.
   g. Thomas and Betts.
   h. Phoenix Contact.
5. Insulating and color coding tape:
   a. 3M Co.
   b. Plymouth Bishop Tapes.
   c. Red Seal Electric Co.

2.2 MANUFACTURED UNITS

A. Building Wire:

1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:

1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, including a bare ground conductor.
6. Individual conductor color coding:
   a. ICEA S-58-679, Method 4.
   b. See PART 3 of this Specification Section for additional requirements.
7. Conform to NFPA 70 Type TC and IEEE 1202 or CSA FT-4.

C. Control Cable:

1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Conform to NEMA/ICEA WC 57/S-73-532 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
5. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
   a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
6. Individual conductor color coding:
   a. ICEA S-58-679, Method 1, Table E-2.
   b. See PART 3 of this Specification Section for additional requirements.
7. Conform to NFPA 70 Type TC and IEEE 1202, CSA FT-4 or NFPA 262.

D. Electrical Equipment Control Wire:

1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

E. Shielded VFD Cable:

1. Conductor shall be copper, stranded with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Cables No. 1 AWG and less:
   a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type RHW-2 or XHHW-2 insulation with an overall PVC jacket.

b. Shielding: 85% tinned copper braid, full size tinned copper drain wire and 100% foil shield.
c. Number of conductors: 3 PH and 1 full size ground.

4. Cables No. 12 through 750 kcmil:
   a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.
   b. Shielding: Continuous corrugated copper-free aluminum sheath covered with a PVC jacket or 5 mil copper tape, longitudinally applied with a minimum overlap of 15%.
   c. Number of conductors: 3 PH and 3 equally spaced ground conductors.
5. Individual conductor color coding:
   a. ICEA S-58-679, Method 4.
   b. See PART 3 of this Specification Section for additional requirements.
6. When installed exposed outdoors, UL listed and marked as sunlight resistant.
7. For continuously corrugated cable, use manufacturer approved fittings.
8. Conform to NFPA 70, Type TC and IEEE 1202 or CSA FT-4.

F. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
   a. Tinned copper conductors.
   b. 300 V or 600 V PVC insulation with PVC jacket.
   c. Twisted with 100% foil shield coverage with drain wire.
   d. Six (6) twists per foot minimum.
   e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
   f. Conform to IEEE 1202 or CSA FT-4 or NFPA 262, UL 2250, UL 1581 and NFPA 70 Type ITC.
3. Digital cable:
   a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
   b. Horizontal voice and data cable:
      1) Category 6 per TIA/EIA/ANSI 568.
      2) Cable shall be label-verified.
      3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
      4) Conductors: No. 24 AWG solid untinned copper.
      5) Rated CMP per NFPA 70.
   c. Conform to IEEE 1202 or CSA FT-4 or NFPA 262 and NFPA 70 Type ITC.

G. Wire Connectors:
1. Twist/screw on type:
   a. Insulated pressure or spring type solderless connector.
   b. 600 V rated.
   c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
   d. Phase and neutral conductors: Conform to UL 486C.
2. Compression and mechanical screw type:
   a. 600 V rated.
   b. Ground conductors: Conform to UL 467.
   c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:

a. High density, screw-post barrier-type with white center marker strip.
b. 600 V and ampere rating as required, for power circuits.
c. 600 V, 20 ampere rated for control circuits.
d. 300 V, 15 ampere rated for instrumentation circuits.
e. Conform to NEMA ICS 4 and UL 486A.

H. Insulating and Color Coding Tape:

1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
   a. Insulating tape: Black.
   b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

I. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types:

1. Type XHHW-2:
   a. Building wire and power and control cable in architectural and non-architectural finished areas.
   b. Building wire and power and control cable in conduit in outdoor areas and below grade.
   c. Building wire and power and control cable in cable tray in outdoor areas.
2. Type THHN/THWN and THHN/THWN-2:
   a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.
3. Type SIS and MTW:
   a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Shielded VFD Cable:

1. For wiring between a VFD and motor when routing in cable trays or conduit other than RGS or RAC.

C. Conductor Size Limitations:

1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:

1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
b. Conductors larger than No. 6 AWG:
   1) Insulated phase and neutral conductors shall be identified by one of the following methods:
      a) Continuous colored outer finish along its entire length.
      b) 3 inches of colored tape applied at the termination.
   2) Insulated grounding conductor shall be identified by one of the following methods:
      a) Continuous green outer finish along its entire length.
      b) Stripping the insulation from the entire exposed length.
      c) Using green tape to cover the entire exposed length.
   3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:
   a. Phase and neutral conductors identified with 3 inches of colored tape, per the Table herein, applied at the terminations.
   b. Ground conductor: Bare.
3. Shielded VFD cable ICEA S-58-679, Method 4 with:
   a. Phase conductors identified with 3 inches of colored tape, per the Table herein, applied at the terminations.
   b. Ground conductor: Green color insulation or bare.
4. Control cables ICEA S-58-679, Method 1, Table E-2:
   a. When a bare ground is not provided, one of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
   b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 inches of colored tape, per the Table herein, applied at the terminations.

E. Install all wiring in raceway unless otherwise indicated on the Drawings.

F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
   1. Where specifically indicated on the Drawings.
   2. Where field conditions dictate and written permission is obtained from the Engineer.
   3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
      a. The combinations shall comply with the following:
         1) 12 VDC, 24 VDC and 48 VDC may be combined.
         2) 125 VDC shall be isolated from all other AC and DC circuits.
         3) AC control circuits shall be isolated from all DC circuits.

4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
    a. The combinations shall comply with the following:
        1) Analog signal circuits may be combined.
        2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for similar loads may be combined in a common raceway, such as multiple lighting circuits or multiple receptacle circuits or other 120Vac circuits. Do not combine lighting and receptacle circuits.
    a. Do not combine control device circuits with lighting or receptacle circuits.
    b. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
        1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
        2) The neutral conductors may not be shared.
        3) Up sizing raceway size for the size and quantity of conductors.

G. Ground the drain wire of shielded instrumentation cables at one end only.
    1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

H. Splices (where permitted) and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
    1. Feeder and branch power circuits:
        a. Device outlet boxes:
            1) Twist/screw on type connectors.
        b. Junction and pull boxes and wireways:
            1) Twist/screw on type connectors for use on No. 8 and smaller wire.
            2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
        c. Motor terminal boxes:
            1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
            2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
        d. Manholes or handholes:
            1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
            2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
    2. Control circuits:
        a. Junction and pull boxes: Terminal block type connector.
        b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
        c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
    3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
        a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
        b. Junction and pull boxes: Terminal block type connector.
        c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

I. Insulating Tape Usage:

1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

J. Color Coding Tape Usage: For color coding of conductors.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing:

1. See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 08 13
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 26 32 15 - Engine Generator - Liquid Propane Gas (LPG).

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. InterNational Electrical Testing Association (NETA):
   a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
2. Nationally Recognized Testing Laboratory (NRTL).
3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
   a. 455-78-B, Optical Fibers - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:

1. Testing firm:
   a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
   b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
   a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
   b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
   c. Supervisor certified by NETA or NICET.
      1) As an alternative, supervising technician may be certified by the equipment manufacturer
3. Analysis personnel:
   a. Minimum three years combined field testing and data analysis experience.
   b. Supervisor certified by NETA or NICET.
      1) As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:

1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
   a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

A. Shop Drawings:

1. Equipment Monitoring and Testing Plan.

B. Informational Submittals:

1. Prior to energizing equipment:
   a. Coordinated phasing diagram.
   b. Photocopies of continuity tests.
2. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
   a. Single report containing information including:
      1) Summary of Project.
      2) Information from pre-energization testing.
      3) Testing and monitoring reports.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of specified field acceptance testing requirements.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:

1. Complete electrical testing in three phases:
   a. Pre-energization testing phase.
   b. Equipment energized with no load.
   c. Equipment energized under load.
2. Perform testing in accordance with this Specification Section and NETA ATS.
3. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.
4. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
   a. Contract Drawings and Specifications.
   b. Related construction change documentation.
   c. Approved Shop Drawings.
   d. Approved Operation and Maintenance Manuals.
   e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plan:

1. Approved in accordance with Shop Drawing submittal schedule.
2. Included as a minimum:
   a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
   b. List and description of testing and analysis equipment to be utilized.
   c. List of all equipment to be testing, including:
      1) Name and tag numbers identified in the Contract Documents.

2) Manufacturer's serial numbers.
3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
1. Minimum calibration frequency:
a. Field analog instruments: Not more than 6 months.
b. Field digital instruments: Not more than 12 months.
c. Laboratory instruments: Not more than 12 months.
d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
2. Carry current calibration status and labels on all testing instruments.
3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
1. Provide reports with tabbed sections for each piece of equipment tested.
2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
a. Include legible copies of all forms used to record field test information.
3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment
a. Include data gathering and sample test report forms that will be utilized.
4. In the final report, include as a minimum, the following information for all equipment tested:
a. Equipment identification, including:
1) Name and tag numbers identified in the Contract Documents.
2) Manufacturer's serial numbers.
3) Other pertinent manufacturer identification,
b. Date and time of each test.
c. Ambient conditions including temperature, humidity, and precipitation.
d. Visual inspection report.
e. Description of test and referenced standards, if any, followed while conducting tests.
f. Results of initial and all retesting.
g. Acceptance criteria.
h. "As found" and "as left" conditions.
i. Corrective action, if required, taken to meet acceptance.
j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
k. Instrument calibration dates of all instruments used in testing.
5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:
1. See individual Division 26 Specification Sections for equipment specific testing requirements.
2. Test all electrical equipment.
a. Perform all required NETA testing.
b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchboards:

1. Perform inspections and tests per NETA ATS 7.1.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

B. Transformers - Small Dry Type:

1. Perform inspections and tests per NETA ATS 7.2.1.1.
2. Perform the following additional tests:
   a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2% of nominal under normal load after approval of Engineer.
4. Record as-left tap connections.

C. Transformers - Large Dry Type:

1. Perform inspections and tests per NETA ATS 7.2.1.2.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
4. Adjust tap connections as required to provide secondary voltage within 2-1/2% of nominal under normal load.
5. Record as-left tap connections.

D. Transformers - Liquid Filled:

1. Perform inspections and tests per NETA ATS 7.2.2.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
4. Adjust tap changer setting as required to provide secondary voltage within 2-1/2% of nominal under normal load after approval of Engineer.
5. Record as-left tap changer setting.

E. Transformer Cooling Fans/Temperature Controllers:

1. Verify each temperature sensor is of the correct type and rating and provides the correct output signal at ambient temperature.
2. Using a thermocouple or RTD simulator, verify correct temperature indication and alarm and fan control relay operation by signal injection.
3. Verify operation of controls in manual and automatic mode.
4. Verify operation of all cooling fans, record running current and compare to nameplate value.
5. Verify trip circuit operation where provided.

F. Cable - Low Voltage:

1. Perform inspections and tests per NETA ATS 7.3.2.

G. Cable - Optical Fiber:

1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
   a. Optical time domain reflectometer test.
   b. Power attenuation test.
   c. Gain margin test.

d.

H. Low Voltage Molded Case Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.6.1.1.
2. Components:
   a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
   c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
3. Record as-left settings.

I. Network Protectors:

1. Perform inspections and tests per NETA ATS 7.8.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform all tests identified as optional per NETA ATS:
4. Perform the following additional tests:
   a. Verify reverse current sensitivity by opening transformer primary switch with feeder energized and no load on transformer and observing that network protector opens on magnetizing current alone.

J. Protective Relays:

1. Perform inspections and tests per NETA ATS 7.9.
   a. Tests to be performed using secondary injection of 3 PH current and potential at final settings.
   b. Test at manufacturer's recommended test points and critical timing points identified on relay setting sheet.
2. Perform all tests identified as optional per NETA ATS.
3. Perform the following additional tests:
   a. Verification of direct trip of associated lockout relay or circuit breaker(s) by using relay test function or shorting trip contact at relay case.
   b. Microprocessor-based relays:
      1) Complete commissioning procedure per manufacturer's instructions, followed by tests of each relay element at final settings.
      2) Verification of all internally-programmed logic.
   c. Verification of all auxiliary input and output signals.
   d. Verification of power supply/self-diagnostic alarm contact and remote annunciation.
4. Record as-left settings.

K. Instrument Transformers:

1. Perform inspections and tests per NETA ATS 7.10.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
   a. Dielectric withstand test on potential transformers.

L. Metering:

1. Perform inspections and tests per NETA ATS 7.11.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

M. Grounding:

1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

N. Ground Fault Protection:

1. Perform inspections and tests per NETA ATS 7.14.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
   a. Control wiring insulation resistance.
4. Perform the following additional tests for four-wire systems:
   a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
   b. Verify no tripping for unbalanced load on each feeder and each main breaker.
   c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
   d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
   e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

O. Motors:

1. Perform inspections and tests per NETA ATS 7.15.
2. Testing of motors:
   a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 200 HP or above.
   b. Ensure motor has been lubricated.
   c. Bump motor to check for correct rotation.

P. Motor Controllers:

1. Perform inspections and tests per NETA ATS 7.16 and 7.17.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

Q. Generators:

1. Perform inspections and tests per NETA ATS 7.15.2.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Load and cycle crank test per Specification Section 26 32 15.

R. Control System Functional Test:

1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
4. Perform the following tests:
   a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
   b. Verify the correct operation of all sensing devices, alarms and indicating devices.

5. Systems to be tested:
    a. Digital Metering System.
    b. Standby Generator Systems.
    c. Automatic Transfer Switch Schemes.

END OF SECTION

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26 20 00

ELECTRICAL DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 GENERAL INFORMATION

A. This Section covers the electrical distribution associated with the Bannock Pumping Plant Modernization project area.

1.2 REFERENCES

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

1. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering

2. ASTM INTERNATIONAL (ASTM)

ASTM B1	(2013) Standard Specification for Hard-Drawn Copper Wire
ASTM B8	(2011; R 2017) Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM D709	(2017) Standard Specification for Laminated Thermosetting Materials

3. INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 81	(2012) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE C2	(2023;) National Electrical Safety Code

4. INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2025) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

5. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.7	(2014) Requirements for Watthour Meter Sockets
ANSI C80.1	(2005) American National Standard for Electrical Rigid Steel Conduit (ERSC)
ANSI C80.5	(2015) American National Standard for Electrical Rigid Aluminum Conduit
NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FU 1	(2012) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures
NEMA KS 1	(2013) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA MG 1	(2016; SUPP 2016) Motors and Generators
NEMA MG 10	(2017) Energy Management Guide for Selection and Use of Fixed Frequency Medium AC Squirrel-Cage Polyphase Induction Motors
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors

NEMA RN 1	(2005; R 2013) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA ST 20	(1992; R 1997) Standard for Dry-Type Transformers for General Applications
NEMA TC 2	(2013) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2016) Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA TP 1	(2002) Guide for Determining Energy Efficiency for Distribution Transformers
NEMA WD 1	(1999; R 2015) Standard for General Color Requirements for Wiring Devices
NEMA WD 6	(2016) Wiring Devices Dimensions Specifications
NEMA Z535.4	(2011; R 2017) Product Safety Signs and Labels

6. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code
NFPA 70E	(2024) Standard for Electrical Safety in the Workplace

7. TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA-607	(2015c; Addendum 1 2017) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

8. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.147	The Control of Hazardous Energy (Lock Out/Tag Out)

9. UNDERWRITERS LABORATORIES (UL)

UL 1	(2023) UL Standard for Flexible Metal Conduit
UL 98	(2023) Standard for Safety Enclosed and Dead-Front Switches.
UL 1008	(2022) Standard for Safety Transfer Switch Equipment
UL 1063	(2017) UL Standard for Safety Machine-Tool Wires and Cables
UL 1203	(2013; Reprint Apr 2018) UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
UL 1242	(2006; R 2022) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 1283	(2017) UL Standard for Safety Electromagnetic Interference Filters
UL 1449	(2021) UL Standard for Safety Surge Protective Devices
UL 1561	(2011; R 2020) Dry-Type General Purpose and Power Transformers
UL 1660	(2014) Liquid-Tight Flexible Nonmetallic Conduit
UL 20	(2010; Reprint Feb 2012) General-Use Snap Switches
UL 360	(2013; R 2024) UL Standard for Safety Liquid-Tight Flexible Metal Conduit
UL 4248-1	(2017) UL Standard for Safety Fuse holders - Part 1: General Requirements
UL 4248-12	(2018) UL Standard for Safety Fuse holders - Part 12: Class R
UL 44	(2018) UL Standard for Safety Thermoset-Insulated Wires and Cables
UL 467	(2013; Reprint Jun 2017) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2018) UL Standard for Safety Wire Connectors
UL 486C	(2018) UL Standard for Safety Splicing Wire Connectors
UL 489	(2025) UL Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

UL 498	(2017; R 2024) UL Standard for Safety Attachment Plugs and Receptacles
UL 5	(2016) UL Standard for Safety Surface Metal Raceways and Fittings
UL 50	(2015) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 506	(2017) UL Standard for Safety Specialty Transformers
UL 508	(2018) UL Standard for Safety Industrial Control Equipment
UL 510	(2017) UL Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(2013; Reprint Aug 2017) UL Standard for Safety Metallic Outlet Boxes
UL 514B	(2012; Reprint Nov 2014) Conduit, Tubing and Cable Fittings
UL 514C	(2014; Reprint Nov 2018) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 5A	(2015) Nonmetallic Surface Raceways and Fittings
UL 6	(2022) Electrical Rigid Metal Conduit-Steel
UL 651	(2011; Reprint Nov 2018) UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 67	(2018) UL Standard for Safety Panelboards
UL 6A	(2008; Reprint Nov 2014) Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
UL 719	(2015; Reprint Nov 2018) UL Standard for Safety Nonmetallic-Sheathed Cables
UL 817	(2015; Reprint May 2017) UL Standard for Safety Cord Sets and Power-Supply Cords
UL 83	(2017) UL Standard for Safety Thermoplastic-Insulated Wires and Cables
UL 845	(2021; R 2025) UL Standard for Safety Motor Control Centers
UL 854	(2020; R 2024) Standard for Service-Entrance Cables
UL 857	(2009; Reprint Aug 2016) UL Standard for Safety Busways
UL 869A	(2006; R 2020) Reference Standard for Service Equipment
UL 870	(2016) UL Standard for Safety Wireways, Auxiliary Gutters, and Associated Fittings
UL 943	(2016; R 2023) UL Standard for Safety Ground-Fault Circuit-Interrupters
UL 984	(1996; Reprint Sep 2005) Hermetic Refrigerant Motor-Compressors

1.3 DEFINITIONS

A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

1.4 SUBMITTALS

A. Owner approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Owner. Submit the following in accordance with Section 01 33 00.

1. SD-02 Shop Drawings
   a. Switchboards; G
   b. Panelboards; G
   c. Transformers; G
   d. Motor control centers; G

Include 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 a coordinated installation. Identify circuit terminals on wiring diagrams and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Indicate on the drawings adequate clearance for operation, maintenance, and replacement of operating equipment devices.

e. Wireways; G

2. SD-03 Product Data
   a. Switchboards;G
   b. Panelboards; G
   c. Receptacles; G
   d. Circuit breakers; G
   e. Switches; G
   f. Transformers; G
   g. Enclosed circuit breakers; G
   h. Motor controllers; G
   i. Combination motor controllers; G
   j. Motor Circuit Protectors; G
   k. Manual motor starters; G
   l. Metering; G
   m. Grounding Busbar; G
   n. Surge protective devices; G
   o. Include performance and characteristic curves.
3. SD-06 Test Reports
   a. 600-volt wiring test; G
   b. Grounding system test; G
   c. Transformer tests; G
   d. Ground-fault receptacle test; G
4. SD-07 Certificates
   a. Fuses; G
5. SD-09 Manufacturer's Field Reports
   a. Transformer factory tests
6. SD-10 Operation and Maintenance Data
   a. Electrical Systems, Data Package 5; G

   Submit operation and maintenance data in accordance with Section 01 78 23, OPERATION AND MAINTENANCE DATA and as specified herein.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements

1. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" or "must" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Owner. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

B. Standard Products

1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship and:

a. Have been in satisfactory commercial or industrial use for 2 years prior to bid opening including applications of equipment and materials under similar circumstances and of similar size.
b. Have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
c. Where two or more items of the same class of equipment are required, provide products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

2. Alternative Qualifications
   a. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.
3. Material and Equipment Manufacturing Date
   a. Products manufactured more than 3 years prior to date of delivery to site are not acceptable.

1.6 MAINTENANCE

A. Electrical Systems
   1. Submit operation and maintenance manuals for electrical systems that provide basic data relating to the design, operation, and maintenance of the electrical distribution system for the building. Include the following:
      a. Single line diagram of the "as-built" building electrical system.
      b. Schematic diagram of electrical control system (other than HVAC, covered elsewhere).
      c. Manufacturers' operating and maintenance manuals on active electrical equipment.

1.7 WARRANTY

A. Provide equipment items supported by service organizations that are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. As a minimum, meet requirements of UL, where UL standards are established for those items, and requirements of NFPA 70 for all materials, equipment, and devices.

2.2 CONDUIT AND FITTINGS

A. Conduit is not allowed within the Floating Steel Structure (FSS) unless specifically noted in accordance with American Bureau of Shipping (ABS) standards. Use cable tray to route electrical conductors that transition outside of the compartment where the conduit originates.

B. Conduit is allowed within the FSS only where routing is limited to within a given compartment. Conduit may not be routed through walls, bulkheads, etc. without approval and meeting specific installation requirements for shipboard use of conduit. Conduit is permitted where routing is entirely above deck.

C. Ground all conduit and Raceway in accordance with Section 26 05 19 INSULATED WIRE AND CABLE and MIL-STD-1310H.

D. Conform to the following:
   1. Rigid Metallic Conduit (RMC)
      a. Rigid, Threaded Zinc-Coated Steel Conduit
         1) Where allowed, provide hot dipped galvanized rigid metal conduit complying with ANSI C80.1 and UL 6. Where installed in corrosive areas, provide polyvinylchloride

(PVC), or painted with bitumastic coated rigid metal conduit in accordance with NEMA RN 1.

2) Use threaded fittings for RMC, cadmium- or zinc-coated in accordance with UL 514B. Split couplings unacceptable.

3) Use solid gaskets. Ensure conduit fittings with blank covers have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

4) Provide covers with captive screws and covers shall be accessible after the work has been completed.

2. Intermediate Metal Conduit (IMC)
   a. Ensure intermediate metal conduit is galvanized steel and complies with UL 1242.
   b. Use threaded fittings for IMC, cadmium- or zinc-coated in accordance with UL 514B. Split couplings unacceptable.
3. Electrical Metallic Tubing (EMT)
   a. EMT is not allowed.
4. Flexible Metallic Conduit (FMC)
   a. Ensure flexible metallic conduit is galvanized steel and complies with UL 1.
   b. Ensure fittings for flexible metallic conduit are specifically designed for such conduit, cadmium- or zinc-coated in accordance with UL 514B.
   c. Provide liquidtight flexible metallic conduit (LFMC) compliant with UL 360. LFMC shall have a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.
   d. Ensure fittings for liquidtight flexible metallic conduit are specifically designed for such conduit.
5. Rigid Nonmetallic Conduit (RNC)
   a. Ensure rigid nonmetallic conduit complies with NEMA TC 2, and UL 651, with a wall thickness not less than Schedule 40.
   b. Fittings shall be compliant with NEMA TC 3 and UL 651.
6. Wireways and Auxiliary Gutters
   a. Ensure wire ways and auxiliary gutters are a minimum 4 by 4-inch trade size conforming to UL 870.

2.3 CABLE TRAYS

A. Provide cable trays conforming to NEMA VE 1. Provide the following:

1. Cable trays: form a wireway system, with a nominal3 depth or as indicated.
2. Cable trays: constructed of aluminum.
3. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.
4. Edges, fittings, and hardware: finished free from burrs and sharp edges.
5. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.
6. Radius of bends: as indicated, with minimum 12 inches.

B. Basket-Type Cable Trays

1. Provide size as indicated, minimum 4 in width, 4 inch depth. Maximum wire mesh spacing of 2 by 4 inch.

C. Ladder-Type Cable Trays

1. Provide size as indicated with maximum rung spacing of 6 inches.

D. Cantilever

1. Cantilever-type, center-hung cable trays may be provided at the Contractor's option in lieu of other cable tray types specified.

2.4 OUTLET BOXES AND COVERS

A. Boxes for metallic raceways: cast-metal, hub-type when located in wet locations, when surface mounted on outside of exterior surfaces, when surface mounted on interior walls exposed up to 7 feet above floors and walkways, and when specifically indicated. Boxes in other locations: sheet steel.

B. Provide each box with volume required by NFPA 70 for number of conductors enclosed in box. Boxes for mounting lighting fixtures: minimum 4 inches square, or octagonal, except that smaller boxes may be installed as required by fixture configurations, as approved.

C. Provide gaskets for cast-metal boxes installed in wet locations and boxes installed flush with outside of exterior surfaces. Provide separate boxes for flush fixtures when required by fixture terminal operating temperature; provide readily removable fixtures for access to boxes unless ceiling access panels are provided.

D. UL 514A, cadmium- or zinc-coated, if ferrous metal. UL 514C, if nonmetallic.

E. Boxes for use with raceway systems: minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets: minimum 4 inches square, except that 4 by 2 inch boxes may be used where only one raceway enters outlet. Telecommunications outlets: a minimum of 4 inches square by 2 1/8 inches deep.

1. Extension Rings
   a. Extension rings are not permitted for new construction.
2. Outlet Boxes
   a. Provide the following:
      1) Boxes: nonadjustable, surface mounted in unfinished areas, recessed in finished areas.
      2) Each outlet: consisting of nonmetallic or cast-metal body with threaded openings, for conduits, ring, and cover plate with 3/4 inch threaded plug.
      3) Telecommunications outlets: consisting of surface-mounted, horizontal, aluminum or stainless steel housing with a receptacle as specified and 3/4 inch top opening.
      4) Receptacle outlets: consisting of surface-mounted, horizontal aluminum or stainless steel housing with duplex-type receptacle as specified herein.
      5) Provide gaskets where necessary to ensure watertight installation.

2.5 CABINETS, JUNCTION BOXES, AND PULL BOXES

A. Construct of at least minimum size required by NFPA 70 of code-gauge aluminum or galvanized sheet steel, except where cast-metal boxes are required in locations specified herein. Provide boxes with screw-fastened covers. Volume greater than 100 cubic inches, UL 50, hot-dip, zinc-coated, if sheet steel.

2.6 WIRES AND CABLES

A. Provide wires and cables in accordance applicable requirements of NFPA 70 and UL for type of insulation, jacket, and conductor specified or indicated. Do not use wires and cables manufactured more than 12 months prior to date of delivery to site.

1. Conductors
   a. Refer to Section 26 05 19 for requirements for insulated wire and cables.

2.7 SPLICES AND TERMINATION COMPONENTS

A. Splices are not allowed unless specifically identified in the contract drawings.

B. Where permitted, adhere to UL 486A-486B for wire connectors and UL 510 for insulating tapes. Connectors for No. 10 AWG and smaller diameter wires: insulated, pressure-type in accordance with UL 486A-486B or UL 486C (twist-on splicing connector). Provide solderless terminal lugs on stranded conductors.

2.8 DEVICE PLATES

A. Provide the following:

1. UL listed, one-piece device plates for outlets to suit the devices installed.
2. For metal outlet boxes, plates on unfinished walls: zinc-coated sheet steel or cast metal having round or beveled edges.
3. For nonmetallic boxes and fittings, other suitable plates may be provided.
4. Plates on finished walls: nylon or lexan, minimum 0.03 inch wall thickness and same color as receptacle or toggle switch with which they are mounted.
5. Screws: machine-type with countersunk heads in color to match finish of plate.
6. Sectional type device plates are not permitted.
7. Plates installed in wet locations: gasketed and UL listed for "wet locations."

2.9 SWITCHES

A. Toggle Switches

1. NEMA WD 1, UL 20, single pole, three-way, and four-way, totally enclosed with bodies of thermoplastic or thermoset plastic and mounting strap with grounding screw. Include the following:
   a. Handles: white thermoplastic.
   b. Wiring terminals: screw-type, side-wired.
   c. Contacts: silver-cadmium and contact arm - one-piece copper alloy.
   d. Switches: rated quiet-type ac only, 120/277 volts, with current rating and number of poles indicated.

B. Safety Switches

1. NEMA KS 1. Provide heavy duty-type switches where indicated, where switches are rated higher than 240 volts, and for double-throw switches. Provide horsepower rated for switches serving as the motor-disconnect means. Provide switches in NEMA 12, 3R, or 4X, enclosure as indicated, or as required for installed location, per NEMA ICS 6.

C. Transfer Switches

1. Manual Transfer Switch
   a. NEMA KS 1, UL 98. Provide manual transfer switches where indicated, and for double-throw switches. Provide double throw load break rated with quick make/quick break operating mechanism, deionizing arc chutes, with double break rotary action shaft and switchblades manufactured as one common component.
   b. Provide switches in NEMA ratings as required for installed location:
      1) 12: Indoor, sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      2) 3R, or 4X (stainless type 304 or 316): Exterior, with external mounting flanges, hinged, gasketed, lockable door, and no knockouts.
2. Automatic Transfer Switch
   a. UL 1008. Electrically operated mechanically held, double throw, air-break type. Silver-surface main contacts and protect by arcing contacts. Switch shall have provisions for visual inspection of switch blades and contacts. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative. Make all

contacts and coils readily accessible for replacement from front of panel without major disassembly.

b. Ratings: Continuous duty in both normal and emergency. Three-phase four-pole, four-wire. Voltage and current ratings as indicated on the Drawings. Short circuit withstand rating equal to or greater than the normal source electrical gear.

c. Operation: Microprocessor based control module. Open transition. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.

   Normal source voltage sensing.

   1) Adjustable pickup from 85-100% of rated voltage, factory set 90%.
   2) Adjustable dropout from 75-98% of pickup setting, factory set 85%.

   Emergency source voltage and frequency sensing:

   3) Adjustable pickup from 85-100% of rated voltage, factory set 90%.
   4) Fixed voltage dropout at 85% of pickup setting.
   5) Adjustable pickup from 90-100% of rated frequency, factory set 95%.
   6) Fixed frequency dropout at 88% of pickup setting.

d. Time delays:

   1) Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.
   2) Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.
   3) Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source. Automatically bypassed when emergency source fails and normal source is available.
   4) Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.

e. Exerciser timer: Enable and disable function. Selectable to exercise with or without transferring load. Adjustable exercise duration from 1 minute to 24 hours, factory set at 15 minutes. Adjustable day of the week exercise setting, factory set for Monday.

f. In-phase monitor: Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences. In-phase transfer accomplished if both sources are within 2 Hz of rated frequency and 70% or more of rated voltage.

g. Enclosure: NEMA 12 rated. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out. No knockouts, hinged and lockable door.

2.10 FUSES

A. Submit coordination data as specified in paragraph, FUSES of this section.

2.11 RECEPTACLES

A. Provide the following:

1. UL 498, hard use (also designated heavy-duty), grounding-type.
2. Ratings and configurations: as indicated.
3. Bodies: white as per NEMA WD 1.
4. Face and body: thermoplastic supported on a metal mounting strap.
5. Dimensional requirements: per NEMA WD 6.

6. Screw-type, side-wired wiring terminals.
7. Grounding pole connected to mounting strap.
8. The receptacle: containing triple-wipe power contacts and double or triple-wipe ground contacts.
9. All receptacles shall be GFCI rated.

B. Weatherproof Receptacles

1. Provide receptacles, UL listed for use in "wet locations". Include cast metal box with gasketed, hinged, lockable and weatherproof while-in-use, die-cast metal/aluminum cover plate.

C. Ground-Fault Circuit Interrupter Receptacles

1. UL 943, duplex type for mounting in standard outlet box. Provide device capable of detecting current leak of 6 milliamperes or greater and tripping per requirements of UL 943 for Class A ground-fault circuit interrupter devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

D. Special Purpose Receptacles

1. Receptacles serving welder units are special purpose. Provide in ratings indicated. NEMA 12 configuration, rated 30 amperes, 480 volts.
2. Receptacle serving portable standby generator is special purpose. Provide in rating indicated, NEMA 4X configuration, rated amperes per contract drawings, voltage per contract drawings.

E. Plugs

1. Provide heavy-duty, rubber-covered four-, or five- wire cord of required size, install plugs thereon, and attach to equipment. Provide UL listed plugs with receptacles, complete with grounding blades. Where equipment is not available, turn over plugs and cord assemblies to the Owner.

2.12 PANELBOARDS

A. Provide panelboards in accordance with the following:

1. In compliance with UL 50 and UL 67 having a short-circuit current rating as indicated, 10,000 amperes symmetrical minimum.
2. Panelboards for use as service disconnecting means: additionally conform to UL 869A.
3. Panelboards: circuit breaker-equipped.
4. Designed such that individual breakers can be removed without disturbing adjacent units or without loosening or removing supplemental insulation supplied as means of obtaining clearances as required by UL.
5. "Specific breaker placement" is required in panelboards to match the breaker placement indicated in the panelboard schedule on the drawings.
6. Use of "Subfeed Breakers" is not acceptable unless specifically indicated otherwise.
7. Main breaker: "separately" mounted "above" or "below" branch breakers.
8. Where "space" is indicated in the panel schedule, make provisions for future installation of breakers.
9. Directories: indicate load served by each circuit in panelboard.
10. Directories: indicate source of service to panelboard (e.g., Panel PA served from Panel MDP).
11. Type directories and mount in holder behind transparent protective covering.
12. Panelboards: listed and labeled for their intended use.
13. Panelboard nameplates: provided in accordance with paragraph FIELD FABRICATED NAMEPLATES.

B. Enclosure

1. Provide panelboard and enclosures in accordance with the following:
    a. Cabinets mounted outdoors or surface-mounted: hot-dipped galvanized after fabrication.
    b. Cabinets: painted in accordance with paragraph PAINTING.
    c. Outdoor cabinets: NEMA 4X raintight with conduit hubs welded to the cabinet.
    d. Front edges of cabinets: form-flanged or fitted with structural shapes welded or riveted to the sheet steel, for supporting the panelboard front.
    e. All cabinets: fabricated such that no part of any surface on the finished cabinet deviates from a true plane by more than 1/8 inch.
    f. Cabinets shall be door-in-door construction that enables access to the interior of the panel by opening a hinged door.
    g. Holes: provided in the back of indoor surface-mounted cabinets, with outside spacers and inside stiffeners, for mounting the cabinets with a 1/2 inch clear space between the back of the cabinet and the wall surface.
    h. Flush doors: mounted on hinges that expose only the hinge roll to view when the door is closed.
    i. Each door: fitted with a combined catch and lock, except that doors over 24 inches long provided with a three-point latch having a knob with a T-handle, and a cylinder lock.
    j. Keys: two provided with each lock, with all locks keyed alike.
    k. Finished-head cap screws: provided for mounting the panelboard fronts on the cabinets.

C. Panelboard Buses

1. Bus bars shall be copper. Support bus bars on bases independent of circuit breakers. Design main buses and back pans so that breakers may be changed without machining, drilling, or tapping. Provide isolated neutral bus in each panel for connection of circuit neutral conductors. Provide separate ground bus identified as equipment grounding bus per UL 67 for connecting grounding conductors; bond to steel cabinet.

D. Circuit Breakers

1. Comply with UL 489, thermal magnetic-type having a minimum short-circuit current rating equal to the short-circuit current rating of the panelboard in which the circuit breaker will be mounted. Ensure circuit breaker interrupting rating is not less than the distribution equipment in which it is installed in, and in no event less than 14,000 amperes root-mean-square (rms) symmetrical at 480 volts, 10,000 rms at 208 volts, respectively. Breaker terminals: UL listed as suitable for type of conductor provided. Where indicated on the drawings, provide circuit breakers with shunt trip devices. Series rated circuit breakers and plug-in circuit breakers are unacceptable.
    a. Multipole Breakers
        1) Provide common trip-type with single operating handle. Design breaker such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.
    b. Circuit Breaker With Ground-Fault Circuit Interrupter
        1) UL 943 and NFPA 70. Provide with "push-to-test" button, visible indication of tripped condition, and ability to detect and trip on current imbalance of 6 milliamperes or greater per requirements of UL 943 for Class A ground-fault circuit interrupter.
    c. Circuit Breakers for HVAC Equipment
        1) Provide circuit breakers for HVAC equipment having motors (group or individual) marked for use with HACR type and UL listed as HACR type.

2.13 ENCLOSED CIRCUIT BREAKERS

A. UL 489. Individual molded case circuit breakers with voltage and continuous current ratings, number of poles, overload trip setting, and short circuit current interrupting rating as indicated. Enclosure type as indicated. Provide solid neutral.

2.14 MOTOR SHORT-CIRCUIT PROTECTOR (MSCP)

A. Motor short-circuit protectors, also called motor circuit protectors (MCPs): UL 508 and UL 489, and provided as shown. Provide MSCPs that consist of an adjustable instantaneous trip circuit breaker used only in conjunction with a combination motor controller which provides coordinated motor branch-circuit overload and short-circuit protection. Rate MSCPs in accordance with the requirements of NFPA 70.

2.15 TRANSFORMERS

A. Provide transformers in accordance with the following:

1. NEMA ST 20, general purpose, dry-type, copper windings, 2 windings, 60 Hz, self-cooled, ventilated.
2. Ensure windings have a minimum of two 2-1/2-percent taps above and below nominal voltage.
3. Provide indoor transformers in NEMA 12 enclosure, unless indicated otherwise.
4. Transformer insulation system:
   a. 220 degrees C insulation system for transformers 15 kVA and greater, with temperature rise not exceeding 150 degrees C under full-rated load in maximum ambient of 40 degrees C.
5. Transformer of 150 degrees C temperature rise: capable of carrying continuously 100 percent of nameplate kVA without exceeding insulation rating.
6. Transformers: quiet type with maximum sound level at least 3 decibels less than NEMA standard level for transformer ratings indicated.

B. Specified Transformer Efficiency

1. Transformers, indicated and specified with: 480V primary, 80 degrees C or 115 degrees C temperature rise, kVA ratings of 37.5 to 100 for single phase or 30 to 500 for three phase, energy efficient type. Minimum efficiency, based on factory test results: not be less than NEMA Class 1 efficiency as defined by NEMA TP 1.

C. Motor Sizes

1. Provide size for duty to be performed, not exceeding the full-load nameplate current rating when driven equipment is operated at specified capacity under most severe conditions likely to be encountered. When motor size provided differs from size indicated or specified, make adjustments to wiring, disconnect devices, and branch circuit protection to accommodate equipment actually provided. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage. Provide protection for motors from immediate restart by a time adjustable restart relay.

D. Wiring and Conduit

1. Provide internal wiring for components of packaged equipment as an integral part of the equipment. Provide power wiring and conduit for field-installed equipment, and motor control equipment forming part of motor control centers or switchgear assemblies, the conduit and wiring connecting such centers, assemblies, or other power sources to equipment as specified herein. Power wiring and conduit: conform to the requirements specified herein. Control wiring: provided under, and conform to, the requirements of the section specifying the associated equipment.

2.16 MOTOR CONTROLLERS

A. See Section 26 24 19 for additional requirements.

B. Provide motor controllers in accordance with the following:

1. UL 508, NEMA ICS 1, and NEMA ICS 2.
2. Provide controllers with thermal overload protection in each phase, and one spare normally open auxiliary contact, and one spare normally closed auxiliary contact.
3. Provide controllers for motors rated 1-hp and above with electronic phase-voltage monitors designed to protect motors from phase-loss, undervoltage, and overvoltage.
4. Provide protection for motors from immediate restart by a time adjustable restart relay.
5. When used with pressure, float, or similar automatic-type or maintained-contact switch, provide a hand/off/automatic selector switch with the controller.
6. Connections to selector switch: wired such that only normal automatic regulatory control devices are bypassed when switch is in "hand" position.
7. Safety control devices, such as low and high pressure cutouts, high temperature cutouts, and motor overload protective devices: connected in motor control circuit in "hand" and "automatic" positions.
8. Control circuit connections to hand/off/automatic selector switch or to more than one automatic regulatory control device: made in accordance with indicated or manufacturer's approved wiring diagram.
9. Provide selector switch with the means for locking in any position.
10. Provide a disconnecting means, capable of being locked in the open position, for the motor that is located in sight from the motor location and the driven machinery location. As an alternative, provide a motor controller disconnect, capable of being locked in the open position, to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.
11. Overload protective devices: provide adequate protection to motor windings; be thermal inverse-time-limit type; and include manual reset-type pushbutton on outside of motor controller case.
12. Cover of combination motor controller and manual switch or circuit breaker: interlocked with operating handle of switch or circuit breaker so that cover cannot be opened unless handle of switch or circuit breaker is in "off" position.
13. Minimum short circuit withstand rating of combination motor controller: 14,000 rms symmetrical amperes.

C. Control Wiring

a. Provide control wiring in accordance with Section 26 05 19 Insulated Wire and Cable.

D. Control Circuit Terminal Blocks

1. Provide control circuit terminal blocks in accordance with the following:
   a. NEMA ICS 4.
   b. Control circuit terminal blocks for control wiring: molded or fabricated type with barriers, rated not less than 600 volts.
   c. Provide terminals with removable binding, fillister or washer head screw type, or of the stud type with contact and locking nuts.
   d. Terminals: not less than No. 10 in size with sufficient length and space for connecting at least two indented terminals for 10 AWG conductors to each terminal.
   e. Terminal arrangement: subject to the approval of the Owner with not less than four (4) spare terminals or 10 percent, whichever is greater, provided on each block or group of blocks.
   f. Modular, pull apart, terminal blocks are acceptable provided they are of the channel or rail-mounted type.
   g. Submit data showing that any proposed alternate will accommodate the specified number of wires, are of adequate current-carrying capacity, and are constructed to assure positive contact between current-carrying parts.

2. Types of Terminal Blocks
    a. Short-Circuiting Type: Short-circuiting type terminal blocks: furnished for all current transformer secondary leads with provision for shorting together all leads from each current transformer without first opening any circuit. Terminal blocks: comply with the requirements of paragraph CONTROL CIRCUIT TERMINAL BLOCKS above.
    b. Load Type: Load terminal blocks rated not less than 600 volts and of adequate capacity: provided for the conductors for NEMA Size 3 and smaller motor controllers and for other power circuits, except those for feeder tap units. Provide terminals of either the stud type with contact nuts and locking nuts or of the removable screw type, having length and space for at least two indented terminals of the size required on the conductors to be terminated. For conductors rated more than 50 amperes, provide screws with hexagonal heads. Conducting parts between connected terminals must have adequate contact surface and cross-section to operate without overheating. Provide eEach connected terminal with the circuit designation or wire number placed on or near the terminal in permanent contrasting color.

E. Control Circuits
    1. Control circuits: maximum voltage of 120 volts derived from control transformer in same enclosure. Transformers: conform to UL 506, as applicable. Transformers, other than transformers in bridge circuits: provide primaries wound for voltage available and secondaries wound for correct control circuit voltage. Size transformers so that 80 percent of rated capacity equals connected load. Provide disconnect switch on primary side. Provide fuses in each ungrounded primary feeder. Provide one fused secondary lead with the other lead grounded.

F. Enclosures for Motor Controllers
    1. NEMA ICS 6.

G. Pushbutton Stations
    1. Provide with "start/stop" momentary contacts having one normally open and one normally closed set of contacts, and red lights to indicate when motor is running. Stations: heavy duty, oil-tight design.

H. Pilot and Indicating Lights
    1. Provide LED cluster lamps.

2.17 MANUAL MOTOR STARTERS (MOTOR RATED SWITCHES)

A. Single pole designed for surface mounting with overload protection and pilot lights.

B. Pilot Lights
    1. Provide LED indicating lights per paragraph 2.4.9.2 in Section 26 24 19.

2.18 MOTOR CONTROL CENTERS

A. Provide motor control centers in accordance with Section 26 24 19.

2.19 LOCKOUT REQUIREMENTS

A. Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147. Comply with requirements of Division 23, "Mechanical" for mechanical isolation of machines and other equipment.

2.20 TELECOMMUNICATIONS SYSTEM

A. Provide system of telecommunications wire-supporting structures (pathway), including: outlet boxes, wireways, cable trays, and other accessories for telecommunications outlets and pathway in accordance with TIA-569 and as specified herein.

2.21 GROUNDING AND BONDING EQUIPMENT

A. Ground Bus

1. Copper ground bus: provided in the electrical equipment rooms as indicated.

2.22 MANUFACTURER'S NAMEPLATE

A. Provide on each item of equipment a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.23 FIELD FABRICATED NAMEPLATES

A. Provide field fabricated nameplates in accordance with the following:

1. ASTM D709.
2. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified or as indicated on the drawings.
3. Each nameplate inscription: identify the function and, when applicable, the position.
4. Nameplates: in accordance with Section 10 14 00 Identification Devices.
5. Provide red laminated plastic label with white center core where indicated.
6. Surface: matte finish. Corners: square. Accurately align lettering and engrave into the core.
7. Minimum size of nameplates: 1 by 2.5 inches.
8. Lettering size and style: a minimum of 0.25 inch high normal block style.

2.24 WARNING SIGNS

A. Provide warning signs for flash protection in accordance with NFPA 70E and NEMA Z535.4 for switchboards, panelboards, industrial control panels, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized. Provide field installed signs to warn qualified persons of potential electric arc flash hazards when warning signs are not provided by the manufacturer. Provide marking that is clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

2.25][2.36 METER BASE ONLY

ANSI C12.7. Provide NEMA Type 3R, box-mounted socket, ringless, having jaws compatible with requirements of a class: Idaho Power approved self contained watthour meter. Provide gray plastic closing cover and bypass links. Provide manufacturers standard enclosure color unless otherwise indicated.

2.26 SURGE PROTECTIVE DEVICES

A. Provide parallel type surge protective devices (SPD) which comply with UL 1449 at the service switchboard, panelboards, MCCs, and control panels. Where SPD cannot fit inside the enclosure being protected, provide in a NEMA 12 enclosure per NEMA ICS 6. Use Type 1 or Type 2 SPD and connect on the load side of a dedicated circuit breaker.

1. Provide the following modes of protection:
   a. FOR SINGLE PHASE AND THREE PHASE WYE CONNECTED SYSTEMS-
      1) Phase to phase (L-L)
      2) Each phase to neutral (L-N)
      3) Neutral to ground (N-G)
      4) Phase to ground (L-G)

B. SPDs at the service switchboard: provide with a minimum surge current rating of 80,000 amperes for L-L mode minimum and 40,000 amperes for other modes (L-N, L-G, and N-G) and

downstream SPDs rated 40,000 amperes for L-L mode minimum and 20,000 amperes for other modes (L-N, L-G, and N-G).

1. Provide SPDs. Maximum L-N, L-G, and N-G Voltage Protection Rating:
   a. 700V for 208Y/120V, three phase system
   b. 1,200V for 480Y/277V, three phase system
2. Maximum L-L Voltage Protection Rating:
   a. 1,200V for 208Y/120V, three phase system
   b. 2,000V for 480YV, three phase system

C. The minimum MCOV (Maximum Continuous Operating Voltage) rating for L-N and L-G modes of operation: 120% of nominal voltage for 240 volts and below; 115% of nominal voltage above 240 volts to 480 volts.

D. Provide EMI/RFI filtering per UL 1283 for each mode with the capability to attenuate high frequency noise. Minimum attenuation: 20db.

2.27 FACTORY APPLIED FINISH

A. Provide factory-applied finish on electrical equipment in accordance with the following:

1. NEMA 250 corrosion-resistance test and the additional requirements as specified herein.
2. Interior and exterior steel surfaces of equipment enclosures: thoroughly cleaned followed by a rust-inhibitive phosphatizing or equivalent treatment prior to painting.
3. Exterior surfaces: free from holes, seams, dents, weld marks, loose scale or other imperfections.
4. Interior surfaces: receive not less than one coat of corrosion-resisting paint in accordance with the manufacturer's standard practice.
5. Exterior surfaces: primed, filled where necessary, and given not less than two coats baked enamel with semigloss finish.
6. Equipment located indoors: ANSI Light Gray, and equipment located outdoors: ANSI Light Gray.
7. Provide manufacturer's coatings for touch-up work and as specified in paragraph FIELD APPLIED PAINTING.

2.28 SOURCE QUALITY CONTROL

A. Transformer Factory Tests

1. Submittal: include routine NEMA ST 20 transformer test results on each transformer and also provide the results of NEMA "design" and "prototype" tests that were made on transformers electrically and mechanically equal to those specified.

2.29 COORDINATED POWER SYSTEM PROTECTION

2.30 PREPARE ANALYSES TO EVALUATE THE PROTECTIVE DEVICES PROVIDED UNDER THIS CONTRACT TO ENSURE THEY WILL WORK TOGETHER EFFECTIVELY, TO ISOLATE FAULTS WHILE MINIMIZING DISRUPTIONS TO THE REST OF THE DISTRIBUTION SYSTEM, ENHANCE SAFETY, AND INCREASE SYSTEM RELIABILITY.VIDEO SURVEILLANCE

Video surveillance system includes all cameras, switches, power supplies, computers, software, configuration, communications equipment, cabling, auxiliaries, and other devices required to provide the functionality represented in the Contract Documents.

A. Dome Camera

1. General
   a. Tamper resistant casing rated for outdoor installation
   b. Heater assembly: Activates at 50 °F and deactivates at 70°F.
   c. Printed circuit (PC) board:

1) The 24Vac/12Vdc board shall provide appropriate power to the camera as well as heater and blower assemblies.
2) The board shall have sufficient surge protection against transient voltage spikes that would otherwise damage a camera.

d. Built-In Defogger:
1) The fan shall circulate air in a controlled circular manner throughout the unit in order to direct heated air onto the front window and across the camera lens

e. Polycarbonate cover and casing
f. Color: Coordinate color with Owner
g. Memory: 256 MB RAM, 128 MB Flash
h. Power: Over Ethernet, IEEE 802.3at 25.5 W Type 1 Class 3 input. Power supplies as recommended by manufacturer.
i. Connectors: RJ45 10Base-T/100BaseTX PoE, or as required by manufacturer.
j. Operating Conditions: -50 °F to 122 °F, Humidity 10–85% RH (non-condensing).

2. 1080p High Definition
3. Wide angle
4. Motion sensing
5. LEDs for low level light conditions
6. Field adjustable view angle
7. Pole or wall mounted as indicated in the Contract Drawings.

B. Video Recorder (DVR)
1. Video compression: H.264 Baseline and Main Profile (MPEG-4 Part 10/AVC) Motion JPEG.
2. Frame rate 15 frames per second minimum
3. Intelligent Video: Video motion detection, Active tampering alarm, AXIS Camera Application Platform enabling installation of additional applications.
4. Provide with rack for installation in electrical building.
5. Provide with surge protection suitable for installation conditions.
6. Provide download capability to computer laptop

C. Ethernet Cable
1. Acceptable manufacturers: Industry standard.
2. Video/data interconnects for cameras and illuminators shall utilize unshielded twisted pair (UTP) Broadband Category 6 cable.
3. Cable shall be Power over Ethernet (PoE) capable.
4. UTP Copper Patch cords shall be of the same manufacturer as the installed UTP Copper cables or the manufacturer of the termination equipment.
5. Supply UTP Copper patch cords, in sufficient numbers, proper length to facilitate the complete and operational system.
6. All twisted pairs shall be individually color coded within color-coded bundles to industry standards.
7. Cable installed conduits installed below grade or exposed to the elements shall be Outside Plant (OSP) rated and protected with a filling compound to protect against water intrusion.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electrical installations, including weatherproof locations and ducts, plenums and other air-handling spaces: conform to requirements of NFPA 70 and IEEE C2 and to requirements specified herein.

1. Submersible Droop Cable – FSS Service
   a. FSS service conductors into buildings: terminate at the submersible cable termination enclosure outside building. FSS service conductors are included in specification Section 26 05 19 Wires and Cables.
2. Field Fabricated Nameplates
   a. Refer to Section 10 14 00.
   b. Identification Plates and Warnings
      1) Provide identification plates for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Attach identification plates to process control devices and pilot lights.
      2) Install identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. For circuits 480 volts and above, install conspicuously located warning signs in accordance with OSHA requirements.
   c. Posted Operating Instructions
      1) Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Ensure operating instructions do not fade when exposed to sunlight. Secure instructions to prevent easy removal or peeling.
      2) Ensure each system and principal item of equipment is as specified in the technical sections for use by operation and maintenance personnel. Include the following information with the operating instructions:
         a) Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
         b) Start up, proper adjustment, operating, lubrication, and shutdown procedures.
         c) Safety precautions.
         d) The procedure in the event of equipment failure.
         e) Other items of instruction as recommended by the manufacturer.
3. Wiring Methods
   a. Refer to specification Section 26 05 19 Wires and Cables for installation requirements.
   b. Provide insulated conductors installed in raceway as indicated or specified otherwise or required by NFPA 70 to be installed otherwise. Grounding conductor: Separate from electrical system neutral conductor. Provide insulated green equipment grounding conductor for circuit(s) installed in conduit and raceways. Where permitted, minimum conduit size: 3/4 inch in diameter for low voltage lighting and power circuits.
   c. Pull Wire
      1) Install pull wires in empty raceways. Pull wire: plastic having minimum 200-pound force tensile strength. Leave minimum 36 inches of slack at each end of pull wire.
4. Raceway Installation
   a. Unless indicated otherwise, route raceways to minimize interference with other equipment, systems, personnel access, etc. but maintain accessibility. Install raceways parallel with or at right angles to ceilings, walls, and structural members where located above accessible ceilings and where conduit will be visible after completion of project
   b. Ensure that conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting does not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.
   c. Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and

equipment during the course of construction. Clear any clogged conduit of obstructions or replace conduit.

d. All circuit runs shall be provided with a separate equipment ground conductor, and shall not rely on the conduit, wire way, or cable tray system for means of providing the ground.

e. Rigid Metal Conduit (RMC)
   1) Make field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use long radius conduit for elbows larger than 2-1/2 inches.
   2) Provide a flush coupling for all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, when the floor slab is of sufficient thickness. Otherwise, provide a floor box set flush with the finished floor. For conduits installed for future use, terminate with a coupling and plug; set flush with the floor.

f. Flexible Metallic Conduit (FMC)
   1) Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.
   2) Use bonding wires in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit is not considered a ground conductor.
   3) Make electrical connections to vibration-isolated equipment with flexible metallic conduit.
   4) Use liquidtight flexible metallic conduit in wet and oily locations and to complete the connection to motor-driven equipment.

g. Intermediate Metal Conduit (IMC)
   1) Make all field-made bends and offsets with approved Hickey bending tool or conduit bending machine. Use intermediate metal conduit only for indoor installations.

h. Rigid Nonmetallic Conduit (RNC)
   1) Ensure rigid PVC conduit is direct buried.
   2) Install a green insulated copper grounding conductor in conduit with conductors and solidly connect to ground at each end. Size grounding wires in accordance with NFPA 70.

i. Wireway and Auxiliary Gutter
   1) Bolt together straight sections and fittings to provide a rigid, mechanical connection and electrical continuity. Close dead ends of wireways and auxiliary gutters. Plug all unused conduit openings.
   2) Support wireways for overhead distribution and control circuits at maximum 5-foot intervals.
   3) Ensure auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure contains no switches, overcurrent devices, appliances, or apparatus and is not more than 30 feet long.

j. Cable Trays
   1) Support cable trays from ceiling hangers, equipment bays, floor or wall supports. Cable trays may be mounted on equipment racks. Provide support when the free end extends beyond 3 feet. Maximum support spacing is 6 feet. Support trays 10-inches wide or less by one hanger. Support trays greater than 10 inches wide by two hangers. Bond cable trays at splices.

k. Splices and Connectors
   1) Make all permitted splices in AWG No. 8 and smaller with approved indentor crimp-type connectors and compression tools.
   2) Make all splices in AWG No. 6 and larger with bolted clamp-type connectors. Wrap joints with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

l. Restrictions Applicable to Nonmetallic Conduit

1) PVC Schedule 40 and PVC Schedule 80

a) Do not use in areas where subject to severe physical damage, including but not limited to, mechanical equipment rooms, electrical equipment rooms, and other such areas.

b) Do not use above grade, except where allowed in this section for rising through floor slab or indicated otherwise.

m. Raceway Support

1) Support raceways by pipe straps, wall brackets, threaded rod conduit hangers, or ceiling trapeze. Fasten by wood screws to wood; by toggle bolts on hollow masonry units; by concrete inserts or expansion bolts on concrete or brick; and by machine screws, welded threaded studs, or spring-tension clamps on steel work. Do not weld raceways or pipe straps to steel structures. Do not exceed one-fourth proof test load for load applied to fasteners. Fill unused holes. In partitions of light steel construction, use sheet metal screws. Do not share supporting means between electrical raceways and mechanical piping or ducts.

2) Where conduit crosses facility expansion joints, or crosses from interior to exterior, provide suitable watertight expansion fitting that maintains conduit electrical continuity by bonding jumpers or other means. For conduits greater than 2 1/2 inches inside diameter, provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.

n. Directional Changes in Raceway Runs

1) Make changes in direction of runs with symmetrical bends or cast-metal fittings. Make field-made bends and offsets with hickey or conduit-bending machine. Do not install crushed or deformed conduits. Avoid trapped raceways. Prevent plaster, dirt, or trash from lodging in raceway, boxes, fittings, and equipment during construction. Free clogged raceways of obstructions.

o. Locknuts and Bushings

1) Fasten conduits to sheet metal boxes and cabinets with two locknuts where required by NFPA 70, where insulated bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, use at least minimum single locknut and bushing. Provide locknuts with sharp edges for digging into wall of metal enclosures. Install bushings on ends of conduits, and provide insulating type where required by NFPA 70.

p. Flexible Connections

1) Provide flexible steel conduit between 3 and 6 feet in length for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for motors. Install flexible conduit to allow 20 percent slack. Minimum flexible steel conduit size: 1/2 inch diameter. Provide liquidtight flexible conduit in wet and damp locations and in pump rooms for equipment subject to vibration, noise transmission, movement or motors. Provide separate ground conductor across flexible connections.

q. Telecommunications and Signal System Pathway

1) Install telecommunications pathway in accordance with TIA-569.

a) Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with TIA-568-C.1. Size conduits, wireways, and cable trays in accordance with TIA-569.

b) Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and, telecommunications equipment rooms (backbone cabling): installed in accordance with TIA-569. Size conduits, wireways, and cable trays for telecommunications risers in accordance with TIA-569.

5. Cable Tray Installation
    a. Install and ground in accordance with NFPA 70. In addition, install and ground telecommunications cable tray in accordance with TIA-569, and TIA-607. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Support in accordance with manufacturer recommendations but at not more than 6 foot intervals. Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly. Adjacent cable tray sections: bonded together by connector plates of an identical type as the cable tray sections. For grounding of cable tray system provide No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum. Terminate cable trays 10 inches from both sides of smoke and fire partitions. Install conductors run through smoke and fire partitions in 4 inch rigid steel conduits with grounding bushings, extending 12 inches beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of partitions. Firestop penetrations in accordance with Section 07 84 00, FIRESTOPPING. Provide supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction.
6. Boxes, Outlets, and Supports
    a. Provide boxes in wiring and raceway systems wherever required for pulling of wires, to facilitate conductor installation, making connections, and mounting of devices or fixtures. For conduit runs longer than 100 feet or with more than three right-angle bends, install a pullbox at a convenient intermediate location.
    b. Securely mount boxes and enclosures to the building structure using supports that are independent of the conduit entering or leaving the boxes. Support boxes and pendants for surface-mounted fixtures on suspended ceilings independently of ceiling supports. Fasten boxes and supports with wood screws on wood, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel. Threaded studs driven in by powder charge and provided with lock-washers and nuts or nail-type nylon anchors may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast boxes threaded to raceways need not be separately supported except where used for fixture support; support sheet metal boxes directly from building structure or by bar hangers. Where bar hangers are used, attach bar to raceways on opposite sides of box, and support raceway with approved-type fastener maximum 24 inches from box. When penetrating reinforced concrete members, avoid cutting reinforcing steel.
        1) Boxes
            a) Mount outlet boxes flush in finished walls.
        2) Pull Boxes
            a) Where several feeders pass through common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.
        3) Extension Rings
            a) Extension rings are not permitted for new construction.
7. Panel Boards
    a. Securely mount panelboards so that the top operating handle does not exceed 72-inches above the finished floor. Do not mount equipment within 42-inches of the front of the panel. Ensure directory card information is complete and legible.
8. Mounting Heights
    a. Mount panelboards, enclosed circuit breakers, motor controller and disconnecting switches so height of operating handle at its highest position is maximum 78 inches above floor. Mount light switches 48 inches above finished floor. Mount receptacles and telecommunications outlets 18 inches above finished floor, unless otherwise indicated. Wall-mounted telecommunications outlets: mounted at height 60 inches above finished floor or as indicated. Mount other devices as indicated. Measure mounting heights of wiring devices and outlets to center of device or outlet.

9. Dry-Type Distribution Transformers
    a. Connect dry-type transformers with flexible metallic conduit.
        1) Mount all dry-type transformers on vibration isolators in accordance with Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.
10. Conductor Identification
    a. Provide conductor identification within each enclosure where tap, or termination is made. For conductors No. 6 AWG and smaller diameter, provide color coding by factory-applied, color-impregnated insulation. For conductors No. 4 AWG and larger diameter, provide color coding by plastic-coated, self-sticking markers; colored nylon cable ties and plates; or heat shrink-type sleeves. Identify control circuit terminations in accordance with Section 23 09 00.00 25 INSTRUMENTATION AND CONTROL FOR HVAC and manufacturer's recommendations.
    b. Marking Strips
        1) Provide marking strips in accordance with the following:
            a) Provide white or other light-colored plastic marking strips, fastened by screws to each terminal block, for wire designations.
            b) Use permanent ink for the wire numbers
            c) Provide reversible marking strips to permit marking both sides or provide two marking strips with each block.
            d) Size marking strips to accommodate the two sets of wire numbers.
            e) Assign a device designation in accordance with NEMA ICS 1 to each device to which a connection is made. Mark each device terminal to which a connection is made with a distinct terminal marking corresponding to the wire designation used on the Contractor's schematic and connection diagrams.
            f) The wire (terminal point) designations used on the Contractor's wiring diagrams and printed on terminal block marking strips may be according to the Contractor's standard practice; however, provide additional wire and cable designations for identification of remote (external) circuits for the Owner's wire designations.
            g) Prints of the marking strips drawings submitted for approval will be so marked and returned to the Contractor for addition of the designations to the terminal strips and tracings, along with any rearrangement of points required.
11. Splices
    a. Splices are not permitted unless expressly indicated in the contract drawings, or as approved by the Owner. Where approved, make splices in accessible locations. Make splices in conductors No. 10 AWG and smaller diameter with insulated, pressure-type connector. Make splices in conductors No. 8 AWG and larger diameter with solderless connector, and cover with insulation material equivalent to conductor insulation.
12. Wiring Devices
    a. Wall Switches and Receptacles
        1) Install wall switches and receptacles so that when device plates are applied, the plates are aligned vertically to within 1/16 inch.
        2) Bond ground terminal of each flush-mounted receptacle to the outlet box with an approved green bonding jumper when used with dry wall type construction.
    b. Device Plates
        1) Ensure device plates for switches are suitably engraved with a description of the loads when not within sight of the loads controlled.
    c. Mark device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets. Show the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Use self-adhesive labels having 1/4 inch embossed letters.

d. Similarly mark device plates for convenience outlets indicating the supply panel and circuit number.

13. Safety Switches
    a. Securely fasten switches to the supporting structure or wall according to the manufacturer’s recommendations, but at a minimum, utilizing a minimum of four 1/4 inch bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height 5 feet above floor level, when possible.
14. Transfer Switches
    a. Installation: Install as indicated and in accordance with manufacturer's recommendations and instructions. Connect as indicated in one-line diagram.
    b. Mounting of manual transfer switches: Wall-mounted.
15. Covers and Device Plates
    a. Install with edges in continuous contact with finished wall surfaces without use of mats or similar devices. Plaster fillings are not permitted. Install plates with alignment tolerance of 1/16 inch. Use of sectional-type device plates are not permitted. Provide gasket for plates installed in wet locations.
16. Electrical Penetrations
    a. Seal openings around electrical penetrations through fire resistance-rated walls, partitions, floors, or ceilings to prevent insect or animal penetration.
17. Grounding and Bonding
    a. Grounding shall be installed in compliance with the NEC, and MIL-STD-1310H.
    b. Ground exposed, non-current-carrying metallic parts of electrical equipment, access flooring support system, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and neutral conductor of wiring systems. Make ground connection at main service equipment, and extend grounding conductor to point of entrance of metallic water service. Make connection to identified locations by suitable ground clamp or lug connection. Interconnect all grounding in or on the structure to provide a common ground potential. This includes electrical service, as well as metallic piping systems. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection.
        1) System Ground Connections
            a) Provide cone pointed ground rods. Measure the resistance to ground using the fall-of-potential method described in IEEE 81. Do not exceed 25 ohms under normally dry conditions for the maximum resistance of a driven ground. If this resistance cannot be obtained with a single rod, up to two additional rods, spaced on center, not less than twice the distance of the length of the rod may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, notify the Owner who will decide on the number of ground rods to add.
        2) Grounding Connections
            a) Make grounding connections which are normally inaccessible, excepting specifically those connections for which access for periodic testing is required, by exothermic weld or compression connector.
                (1) Make exothermic welds strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces indicating improper cleaning are not acceptable. Mechanical connectors are not required at exothermic welds.
                (2) Make compression connections using a hydraulic compression tool to provide the correct circumferential pressure. Provide tools and dies as recommended by the manufacturer. Use an embossing die code or other

standard method to provide visible indication that a connector has been adequately compressed on the ground wire.

3) Ground Bus

a) Provide a copper ground bus in the electrical equipment room as indicated. Noncurrent-carrying metal parts of transformer neutrals and other electrical equipment: effectively grounded by bonding to the ground bus. Bond the ground bus to both the entrance ground, and to a ground rod or rods as specified above having the upper ends terminating approximately 4 inches above the floor. Make connections and splices of the brazed, welded, bolted, or pressure-connector type, except use pressure connectors or bolted connections for connections to removable equipment

4) Resistance

a) Maximum resistance-to-ground of grounding system: do not exceed 5 ohms under dry conditions. Where resistance obtained exceeds 5 ohms, contact Contracting Officer for further instructions.

18. Equipment Connections

a. Provide power wiring for the connection of motors and control equipment under this section of the specification. Except as otherwise specifically noted or specified, automatic control wiring, control devices, and protective devices within the control circuitry are not included in this section of the specifications and are provided under the section specifying the associated equipment.

19. Owner-Furnished Equipment

a. Contractor rough-in for Owner-furnished equipment make connections to Owner-furnished equipment to make equipment operate as intended, including providing miscellaneous items such as plugs, receptacles, wire, cable, conduit, flexible conduit, and outlet boxes or fittings.

20. Workmanship

a. Lay out work in advance. Exercise care where cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, or other surfaces is necessary for proper installation, support, or anchorage of conduit, raceways, or other electrical work. Repair damage to buildings, piping, and equipment using skilled craftsmen of trades involved.

21. Surge Protective Devices

a. Connect the surge protective devices in parallel to the power source, keeping the conductors as short and straight as practically possible. Maximum allowed lead length is 3 feet.

3.2 VIDEO SURVEILLANCE

A. Contractor is responsible for the functional operations of the system, including installation, performance, O&M manual data, start-up, and training.

B. All cameras shall be continuously recorded on the associated network video recorders.

C. Provide sufficient server capacity to store imagery as follows:

1. All cameras.
2. H.264 High Profile video signal at 50% activity.
3. Frame rate of at least 10 images per second.
4. Camera resolution of 2048x1536.
5. For 30 days.

D. General

1. Provide tamper-resistant installation utilizing “torx with peg” security fastening devices.

2. Install component/devices in accordance with the manufacturer's instructions.
3. Make all cable splices in tamper-resistant, accessible junction boxes.
4. Provide identification devices for instrumentation system components in accordance with 26 05 00.
5. Provide corrosion resistant spacers to maintain ¼-inch separation between equipment and mounting surface in wet areas and on below grade walls.
6. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.
7. Adjust camera view and focus all cameras during installation. Verify and coordinate all camera views with Owner.
8. The Contractor shall provide CD-ROM verification of cable testing results indicating date of test performed and results, signed by job foreman.
9. Furnish labeling according to ANSI/TIA/EIA 606A document. Consult with Owner's telecom representative

E. Spare Parts – Provide Owner with the following:

1. One (1) camera housing.
2. One (1) power supply.
3. One (1) camera.
4. One (1) lens.
5. One (1) illuminator.
6. One (1) Video Recorder.
7. One (1) hard drive.
8. One (1) Field Equipment Ethernet Switch.
9. All extra materials shall be furnished to the owner in original unopened manufacturer packaging, and include all original product documentation.

3.3 FIELD FABRICATED NAMEPLATE MOUNTING

A. Provide number, location, and letter designation of nameplates as required. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets.

3.4 WARNING SIGN MOUNTING

A. Provide the number of signs required to be readable from each accessible side. Space the signs in accordance with NFPA 70E.

3.5 FIELD APPLIED PAINTING

A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Painting: as specified in Section 09 97 00 PAINTING: HYDRAULIC STRUCTURES. Where field painting of enclosures for panelboards or the like is specified to match adjacent surfaces, to correct damage to the manufacturer's factory applied coatings, or to meet the indicated or specified safety criteria, provide manufacturer's recommended coatings and apply in accordance to manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

A. After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

B. Provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

C. Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Use substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices to isolate the circuits under test.

D. Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment in a clockwise direction, facing the source.

E. Final acceptance requires the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the Contracting Officer.

F. Furnish test equipment and personnel and submit written copies of test results. Submit test reports in accordance with referenced standards in this section. Give Contracting Officer 5 working days notice prior to each test.

1. Devices Subject to Manual Operation
   a. Operate each device subject to manual operation at least five times, demonstrating satisfactory operation each time.
2. 600-Volt Wiring Test
   a. Test wiring rated 600 volt and less to verify that no short circuits or accidental grounds exist. Perform insulation resistance tests on wiring No. 6 AWG and larger diameter using instrument which applies voltage of approximately 500 volts to provide direct reading of resistance. Minimum resistance: 250,000 ohms.
   b. Perform insulation-resistance test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential is 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values is not less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes AWG No. 8 and smaller insulation resistance testing is not required.
   c. Perform continuity test to insure correct cable connection end-to-end (i.e correct phase conductor, grounded conductor, and grounding conductor wiring). Repair and verify any damages to existing or new electrical equipment resulting from mis-wiring. Receive approval for all repairs from the Contracting Officer prior to commencement of the repair.
3. Transformer Tests
   a. Perform the standard, not optional, tests in accordance with the Inspection and Test Procedures for transformers, dry type, air-cooled, 600 volt and below; as specified in NETA ATS. Measure primary and secondary voltages for proper tap settings. Tests need not be performed by a recognized independent testing firm or independent electrical consulting firm.
4. Ground-Fault Receptacle Test
   a. Test ground-fault receptacles with a "load" (such as a plug in light) to verify that the "line" and "load" leads are not reversed.
5. Grounding System Test
   a. Test grounding system to ensure continuity, and that resistance to ground is not excessive. Test each ground rod for resistance to ground before making connections to

rod; tie grounding system together and test for resistance to ground. Make resistance measurements in dry weather, not earlier than 48 hours after rainfall. Submit written results of each test to Owner, and indicate location of rods as well as resistance and soil conditions at time measurements were made.

6. Transfer Switch
   a. Automatic Transfer Switch Testing:
      1) Simulate power outage by opening normal source overcurrent device. Verify engine generator starts and switch transfers in the specified time.
      2) Close normal source overcurrent device to simulate the return of normal power. Verify the switch retransfers and engine generator shuts down in the specified time.
      3) Perform a manual transfer and retransfer.
      4) Verify the indicator lights function properly.
7. Other Systems
   a. Refer to specification Section 26 08 13 Apparatus Inspection and Testing for additional testing requirements.

END OF SECTION

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SECTION 26 24 19
MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motor control centers.
2. Separately mounted motor starters (including those supplied with equipment).
3. Manual motor starters.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 26 05 00 - Electrical - Basic Requirements.
2. Section 26 20 00 – Electrical Distribution System
3. Section 26 29 23 - Variable Frequency Drives - Low Voltage.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. International Electrotechnical Commission (IEC).
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
   b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
   c. ICS 18, Motor Control Centers.
3. Underwriters Laboratories, Inc. (UL):
   a. 508, Standard for Industrial Control Equipment.
   b. 845, Motor Control Centers.

B. Miscellaneous:

1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 26 05 00 for additional requirements.
2. Fabrication and/or layout drawings:
   a. Motor control center:
      1) Elevation drawing with overall dimensions.
      2) Starter and component schedule.
      3) Identification of units and their location in the MCC.
      4) Location of incoming line terminals.
      5) Mounting dimensions.
      6) Available conduit entrance areas.
      7) Nameplate schedule.
      8) Assembly ratings (amps, volts, short circuit, etc.).

9) Unit ladder logic wiring for each unit depicting electrical interlocking and wiring between units (NEMA ICS 18 Class II) and identification of terminals where field devices or remote control signals are to be terminated (NEMA ICS 18 Class II-S) including industry standard symbology of the field devices as indicated on the Drawings, product specification and/or loop descriptions. Drawings indicate basic control functionality, provide diagrams for the manufacturer's product(s) meeting the required functionality.

b. Separately mounted combination starters:

1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated including industry standard symbology of the field devices as indicated on the Drawings, specification and/or loop descriptions. Drawings indicate basic control functionality, provide diagrams for the manufacturer's product(s) meeting the required functionality.

2) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

b. Fabrication and/or layout drawings updated with as-built conditions.

C. Informational Submittals:

1. Equipment marking and documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Allen-Bradley by Rockwell Automation, Inc.
2. c3controls.
3. Eaton.
4. GE by ABB.
5. Square D by Schneider Electric.
6. Siemens Corporation.

2.2 MOTOR CONTROL CENTERS

A. Ratings:

1. 600 V class, 3 PH, 60 Hz with operating voltage and number of wires as indicated on the Drawings.
2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
3. Service Entrance Equipment rated when indicated on the Drawings.

B. Construction:

1. Standards: UL 845.
2. Totally enclosed, dead front, free standing assemblies, bolted together to form a single assembly.
3. Fabricate of not less than 14 GA steel with 16 GA steel doors in standardized units.
4. Nominal size per section: 20 inches wide, 20 or 21 inches deep, and 90 inches high.
5. Enclosure:

a. NEMA 1 gasketed.
b. NEMA 12:
    1) Dust-tight and drip-proof.
    2) Gasketed material round all doors, door cutouts, cover plates, side, top and back sheets.
    3) Gasketed bottom plate.
c. NEMA 3R non-walk-in:
    1) Rainproof and sleet resistant.
    2) NEMA 1 gasketed enclosure with an outdoor house erected around it.

6. Horizontal wireways:
    a. At the top, isolated from the main bus
    b. At the bottom.
    c. Easily accessible.
    d. Full length of the MCC.
7. Vertical wireway:
    a. Located in each MCC section that accepts plug-in units.
    b. Connect to top and bottom wireways.
    c. Isolated from the unit interiors.
    d. Accessible through a separate hinged door.
    e. Cable tie supports to hold wiring in place.
8. Unit doors:
    a. Formed round corners and rolled edges.
    b. Minimum of two heavy-duty hinges or continuous piano hinge.
    c. Held closed by means of captive fasteners.
    d. Fabricate to be a part of the structure and not part of the starter.
9. Unit cubicles:
    a. Draw-out type for motor starters through NEMA Size 5, breakers through 400A frame and fusible switches through 400A.
    b. Guide rails for supporting and aligning starters.
        1) Larger motor starters, breakers and fusible switches to be bused or cabled to the main horizontal bus.
    c. Operating handle:
        1) With the unit stabs engaged and door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
        2) Circuit breaker and MCP operators includes a separate TRIPPED position.
        3) Mechanical interlock to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism.
        4) Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism.
        5) Non-defeatable interlock to prevent the installation or removal of a unit unless the disconnect is in the OFF position.
        6) Padlockable in the OFF position.
    d. Control panel:
        1) Provide control devices (selector switch, indicating devices, etc.) as indicated on the Drawings per Specification Section 26 09 16.
    e. Control power:
        1) Control power transformer:

a) 120 V secondary.
b) Fused on primary and secondary side.
c) Sized for 140% of required load.

f. Minimum of one full size space unit (12 inches) for any combination magnetic motor starter or starter without overload relay.
g. One-half full size space unit (6 inches) for circuit breakers 100 A and less.
h. Effectively baffled to isolate any ionized gases which may occur within unit starter.

10. Externally mounted overload relay pushbutton.
11. Assemblies effectively ventilated to allow relocation of starters and other components:
    a. Within the assembly and with the same load.
    b. Without having to compensate for changes in location.
12. Finish: Rust inhibited primer and manufacturer's standard paint inside and out.
13. Provide ample unrestricted space for conduit entry from the bottom.
14. Wiring: NEMA ICS 18 Class II, Type B-D.

C. Buses:

1. Material: Tin-plated copper.
2. Main horizontal bus:
    a. 600 A unless otherwise indicated on the Drawings.
    b. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
3. Vertical buses:
    a. 300 A minimum.
    b. Securely bolted to the horizontal main bus with joint easily accessible for maintenance.
    c. Completely isolated and insulated by means of a barrier.
    d. Extended full length of vertical section to distribute incoming power to each circuit breaker and starter in structure.
        1) Starters NEMA Size 5 and larger and certain other components may be cable connected to the main bus with the approval of the Engineer.
    e. Extend Vertical bus to spaces provided for future equipment.
4. Ground bus:
    a. Extend the full-length of the MCC with provisions for splicing additional sections to either end.
    b. 300 A tin-plated copper.
    c. Solidly grounded to each structure.
    d. Locate near bottom of structure.
    e. Provide for lug connection of equipment ground wires.

D. Overcurrent and Short Circuit Protective Devices:

1. Main device:
    a. Molded case circuit breaker.
    b. Fusible switch.
2. Feeder devices:
    a. Molded case circuit breaker.
    b. Fusible switch.
3. Motor protection with full voltage starters:
    a. Motor circuit protector.
    b. Molded case circuit breaker.

c. Class RK-1 fuse.

4. Motor protection with reduced voltage starters:
   a. Molded case circuit breaker.
   b. Motor circuit protector.
   c. Class RK-1 fuse.
5. See Specification Section 26 20 00 for overcurrent and short circuit protective device requirements.
6. Factory installed.

E. Motor Starters: See requirements within this Specification Section.

F. Surge Protective Device: Integrally mounted, see Specification Section 26 20 00.

G. Power Monitor Metering:
   1. Separate compartment.
   2. See Specification Section 26 20 00 for meter requirements.

H. Miscellaneous:
   1. See Drawings for items provided by other but factory installed (e.g., submersible motor temperature/leak controller, control system gateways or switches).

2.3 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Enclosure:
   1. NEMA 4 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   2. NEMA 4X rated:
      a. Body and cover: Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   3. NEMA 7 and NEMA 9 rated:
      a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
      b. Drilled and tapped openings or tapered threaded hub.
      c. Gasketed cover bolted-down with stainless steel bolts.
      d. External mounting flanges.
      e. Front operating handle padlockable in the OFF position.
   4. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:
   1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
   2. Circuit breaker and MCP operators includes a separate TRIPPED position.
   3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.

4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
5. Padlockable in the OFF position.
6. Exceptions: NEMA 7 and NEMA 9 enclosures.

D. External mounted overload relay pushbutton.

E. Control Devices:

1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.
2. Devices will be accessible with the door closed.

F. Control Power Transformer:

1. 120V secondary.
2. Fused on primary and secondary side.
3. Sized for 140% of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:

1. Motor circuit protector.
2. See Specification Section 26 20 00 for overcurrent and short circuit protective device requirements.
3. Factory installed.

2.4 MOTOR STARTERS

A. Standards:

1. NEMA ICS 2.
2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:

1. NEMA full size rated contactor.
   a. NEMA half sizes and IEC contactors are not permitted.
2. Double-break silver alloy contacts.
3. Overload relays:
   a. Ambient compensated, bimetallic type with interchangeable heaters, 24% adjustability, single phase sensitivity, an isolated arm contact and manual reset.
4. Interlock and auxiliary contacts, wired to terminal blocks:
   a. Holding circuit contact, normally open.
   b. Overload alarm contact, normally open.
   c. Normally open auxiliary contact, for remote run status.
   d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
   e. Two additional normally open spare field replaceable auxiliary contacts.

C. Full Voltage Reversing (FVR) Magnetic Starters:

1. Two FVNR starters with one overload relay assembled together.
2. Mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.
3. See FVNR paragraph for additional requirements.

D. Full Voltage Two-Speed (FV2S) Magnetic Starters:

1. Two FVNR starters with two overload relays assembled together.
2. Configured for two winding or one winding consequent pole motors.
3. See FVNR paragraph for additional requirements.

E. Reduced Voltage Solid State (RVSS) Starters:

1. See Specification Section 26 29 13.

F. Variable Frequency Drives: See Specification Section 26 29 23.

2.5 MANUAL MOTOR STARTERS

A. Standards:

1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:

1. Horsepower rated, for ON/OFF control.
2. Horsepower rated, for ON/OFF control and thermal overload protection.
   a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:

1. NEMA 1 rated:
   a. Galvanized steel or steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
   b. With or without concentric knockouts.
2. NEMA 4 rated:
   a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
   b. No knockouts, external mounting flanges.
3. NEMA 4X rated:
   a. Type 304 or 316 stainless steel.
   b. No knockouts, external mounting flanges.
4. NEMA 7 and NEMA 9 rated:
   a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
   b. Drilled and tapped openings or tapered threaded hub, external mounting flanges.
5. NEMA 12 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
   b. No knockouts, external mounting flanges.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.

C. Mount MCC on 4 inches high concrete pad:

1. Install two, 4 inches wide channel sills flush in pads to support and maintain alignment of the MCC.
2. Align front of MCC with top edge of pad chamfer.

D. Equipment Marking and Documentation:

1. Provide labeling per NFPA 70 and other applicable codes.
2. Service equipment:
   a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
   b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
3. Other than service equipment:
   a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
   b. Available fault current label. (Ref. NFPA 70 Article 408.6)
4. Identify (tag) all equipment and equipment components.
5. Provide labels and tags in accordance with Section 10 14 00.
6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.

E. Provide separately mounted combination starters with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.

1. Determine the SCCR rating by one of the following methods:
   a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
   b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
   c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

F. Overload Heaters:

1. Size for actual motor full load current of the connected motor.
2. For motors with power factor correction capacitors, size to compensate for the capacitors effect on load current.

G. Combination and Manual Starter Enclosures:

1. Permitted uses of NEMA 1 enclosure:
   a. Surface or flush mounted in architecturally finished areas.
   b. Surface mounted above 10 feet in areas designated as dry in architecturally and non-architecturally finished areas.
2. Permitted uses of NEMA 4 enclosure:
   a. Surface mounted in areas designated as wet.
3. Permitted uses of NEMA 4X enclosure:
   a. Surface mounted in areas designated as wet and/or corrosive.
4. Permitted uses of NEMA 7 enclosure:
   a. Surface mounted in areas designated as Class I hazardous.
   b.
5. Permitted uses of NEMA 9 enclosure:
   a. Surface mounted in areas designated as Class II hazardous.

6. Permitted uses of NEMA 12 enclosure:
    a. Surface mounted in areas designated as dry.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 77 19 Closeout Requirements.

END OF SECTION

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SECTION 26 29 23

VARIABLE FREQUENCY DRIVES - LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Variable frequency drives (VFDs) for operation of inverter duty motors.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 10 14 00 - Identification Devices.
2. Section 26 05 00 - Electrical - Basic Requirements.
3. Section 01 61 03 - Equipment - Basic Requirements.
4. Section 40 61 96 – Process Control Descriptions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI).
2. ETL Testing Laboratories (ETL).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
   b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
4. National Electrical Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. MG 1, Motors and Generators.
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC):
      1) Article 430, Motors Motor Circuits, and Controllers.
6. Occupational Safety and Health Administration (OSHA).
7. Underwriters Laboratory, Inc. (UL):
   a. 508, Standard for Industrial Control Equipment.
   b. 508A, Standard for Industrial Control Panels.

B. Qualifications:

1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
   a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
3. VFD Supplier shall maintain an authorized service organization within 300 miles of the Project Site.

C. Coordination:

1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
   a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
2. Motor and VFD coordination: See Specification Section 01 61 03 and Specification Section 26 05 09.
3. VFD shall be supplied complete with all required control components.
   a. Provide control as indicated:
      1) On the electrical drawings.
      2) As specified in this Specification Section.
      3) As specified in the process control system loop descriptions.
         a) See Specification Section 40 61 96.
   b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
      1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.
   c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.
4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.
   a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.
   b. Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

1.3 DEFINITIONS

A. Variable Torque (VT):

1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

B. Constant Torque (CT):

1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.

C. Constant Horsepower:

1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.

D. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

E. Standard Motor: An AC induction motor that fails to comply with one or more requirements of NEMA MG 1 Part 31.

F. Low Voltage: 600 VAC or less.

1.4 SUBMITTALS

A. Shop Drawings:

1. Provide a schedule for each VFD including the following information:
   a. Equipment Tag Number.
   b. VFD Complete Catalog Number.
   c. VFD Amp Frame Size.
   d. Variable or Constant Torque Rating Basis.
   e. Rated Input Current.
   f. Rated Continuous Output Current.
   g. Rated Short Circuit Current.
   h. VFD cable type specified (shielded or non-shielded).
   i. VFD Maximum Motor Lead Length for the type of cable used.
   j. Motor Manufacturer.
   k. Motor Frame Size.
   l. Motor Full Load Amps.
   m. Motor Service Factor.
   n. As installed motor Lead Length.
   o. VFD options provided to meet harmonic or motor protection specifications.
2. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
3. Product technical data:
   a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
   b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
   c. Manufacturer's installation instructions.
   d. Manufacturer's programming and operating instructions.
   e. See Specification Section 26 05 00 for additional requirements.
4. Fabrication and/or layout drawings:
   a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.
   b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
   c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
   d. Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
   e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
   f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
5. Certifications:
   a. Submit with Shop Drawings:
      1) Identification and location of closest authorized service organization.
      2) Harmonic analysis at each PCC per Harmonic Protection Requirements Article.
   b. Submit prior to shipment:
      1) Certified factory test reports confirming compliance with specified requirements.

c. Submit after installation:
   1) Certified field service reports showing:
      a) Each VFD is operational.
      b) Each VFD and its driven equipment motor are compatible.
      c) Each VFD responds correctly to the input control signals.
      d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
      e) Measured harmonic levels per Harmonic Protection Requirements Article.
      f) Measured motor terminal peak voltages per Motor Protection Requirements Article.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Approved copy of VFD schedule per Submittals Article.
   3. Manufacturer's instruction manuals.
   4. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
   5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
   6. Recommended spare parts list.
   7. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

C. Refer to Section 01 81 33 – Cyber Security Requirements for required cyber security related submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen Bradley.
   2. ABB.
   3. Eaton.
   4. Danfoss.
   5. Siemens/Robicon.
   6. Siemens.
   7. Square D Company.
   8. Toshiba.
   9. Yaskawa.

2.2 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.

1. Motor control.
2. Motor overload protection.
3. Motor and motor branch circuit short circuit and ground fault protection.
4. Motor and controller disconnecting means.

C. It is the intent of this Specification that VFDs shall be an “engineered” or “configured” drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:

1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100% of base speed of the driven equipment.
2. VFDs shall be compatible with:
   a. Inverter duty induction motors.
3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications.
   a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify CT and VT applications.
4. VFDs shall be designed to operate successfully under the following site conditions:
   a. Ambient:
      1) Temperature: 0-40 degrees C
      2) 95% non-condensing relative humidity.
   b. Elevation: 5,500 feet above MSL.
   c. Power supply characteristics:
      1) 480Vac, 3 PH, 60 Hz, 3 wire, (±10%).
      2) Effectively grounded.

B. Ratings and Performance Specifications:

1. Voltage rating:
   a. Nominal: 480 VAC, 3 PH, 60 Hz.
   b. Range for continuous full load operation: ±10% of nominal.
   c. Voltage imbalance tolerance for full load operation: 3% minimum.
2. Current ratings:
   a. Continuous:
      1) Equal to or greater than the motor nameplate full load.
   b. Short-term overload:
      1) VT: 110% for 1 minute.
      2) CT: 150% for 1 minute.
      3) Permissible for 1 minute every 10 minutes continuously.
   c. Short circuit:
      1) As indicated on the Drawings.
      2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
      3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.

3. Efficiency:
    a. 97%, minimum, at full speed and full load.
    b. 93%, minimum at 1/2 speed and full load.
4. Displacement power factor:
    a. 95%, minimum from 50% to 100% speed and load.
5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.
6. Frequency drift:
    a. +0.5% of set frequency.
7. Speed regulation (motor dependent): 3%.
8. Speed range: 10:1.
9. Control type:
    a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
        1) When operating under voltage boost.
        2) At frequencies over 60 Hz.

C. Operational Features:
1. Insensitive to input phase sequence.
2. Continued operation with momentary voltage dips of 25% of rated voltage, or single phase condition: 4 seconds, minimum.
3. Controls power loss ride-through: 500 MSEC, minimum.
4. Electronic reversing.
5. DC injection braking.
6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
7. Critical frequency band lockout:
    a. Minimum of three settings.
    b. Adjustable bandwidth, 1 - 5 Hz.
8. Capable of operating without the motor connected for start-up and troubleshooting.

D. The VFD shall be provided with the following minimum user-programmable parameters:
1. Carrier frequency.
2. Independent maximum and minimum speeds for forward and reverse operation.
3. Start frequency and hold time.
4. Independent linear acceleration and deceleration time.
5. Preset “jog” speed.
6. Three critical frequency bands.
7. One preset speed selectable by logic input.
8. Volts/Hertz ratio.
9. Voltage boost, magnitude and frequency range.
10. Process controller gain, offset and bias.
11. Current limit.
12. Overcurrent pickup.
13. Overcurrent delay.
14. Ground fault pickup.
15. DC injection level and time.

E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:

1. General:
   a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
      1) Input under voltage.
      2) Input over voltage.
      3) Input under frequency.
      4) Input over frequency.
      5) Input Phase loss.
      6) DC Bus under voltage.
   b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
      1) Over temperature.
      2) Blown fuse.
      3) Component failure.
      4) Overload.
      5) Short circuit.
      6) Ground fault.
      7) DC Bus over voltage.
      8) External safety input (e.g., motor thermal protection).
      9) Logic fault.
   c. When automatic shutdown occurs, VFD shall restart only when remote run signal is removed and reapplied.
   d. VFD shall hold cause of trip data for a minimum of four shutdowns in memory.
      1) Data to be accessible through the keypad, local communication link and remotely.
2. Input protection:
   a. Input circuit breaker or current-limiting fuses with externally operable disconnect.
      1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
      2) Handle padlockable in the OFF position.
   b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
   c. Incoming line transient suppression.
      1) 6000V peak per IEEE C62.41.
      2) Phase-to-phase and phase-to-ground protection.
   d. Sustained over voltage trip.
3. Internal protection:
   a. Surge suppression and power device snubbers.
   b. Power devices rated at 2.5 times line voltage.
   c. Instantaneous over current trip.
   d. DC bus over voltage trip.
   e. Power device over temperature trip.
   f. Control logic circuit malfunction trip.

4. Output protection:
    a. Inverse-time overload trip:
        1) UL Class 10 characteristic.
    b. Over voltage trip.
    c. Over frequency trip.
    d. Short circuit trip.
        1) Line to line and line to ground.
    e. Ground fault trip.

2.4 OPERATOR AND REMOTE CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.
    1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.

B. Control circuits shall be 120 VAC or 24 VAC or 24 VDC.
    1. 120 VAC supplied by CPT in the VFD.
        a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
        b. CPT shall have two fuses on the primary side and one fuse on the secondary side.
        c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
    2. 24 VAC or 24 VDC supplied by Class 2 power supply in the VFD.
        a. Power supply shall have minimum additional capacity of 33% greater than that required by control devices.
        b. Provide two current-limiting fuses on the AC supply to the power supply.
        c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:
    1. Door mounted sealed keypad, membrane type with LED or LCD display.
        a. Messages shall be in English and engineering units.
        b. Drive operating parameters shall be programmable.
        c. Menu driven.
        d. Password security.
        e. Display fault and diagnostic data.
        f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
        g. Gold plated plug-in contacts.
    2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
        a. Minimum indications:
            1) Run.
            2) Stop.
            3) Ready.
            4) Alarm.
            5) Fault.
            6) Local control.
            7) Remote control.

8) Control source local.
9) Control source remote.
10) Speed indication.

b. Minimum control functions:
1) Local/Remote switch.
2) Stop button.
3) Start button.
4) Reset button.
5) Speed control buttons.

3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.
a. On occurrence of more than one condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:

1. Local portable computer interface via RS232/RS242 serial communications port:
a. Capability to:
1) Start-Stop VFD.
2) Control VFD Speed.
3) Access fault and diagnostic data.

2. Analog and discrete inputs:
a. Speed reference (setpoint) signal 4-20 mA DC or as required by the VFD manufacturer.
b. Isolated process PID controller with user-programmable setpoint, gain, rate, reset and span for accepting a remote 4-20 mA process variable signal.

3. Analog and discrete outputs:
a. 4-20 mA output for remote speed indication, as a function of frequency, calibrated 0 to 100%.
b. Drive FAULT contacts.
c. Drive RUNNING contacts.
d. Drive selector switch in AUTO status contacts.

4. Contacts:
a. Contacts shall be rated 2 A inductive at 120 VAC.
b. All contacts shall be wired to field wiring terminal boards.

5. Drive shutdown on external fault input:
a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
c. Local safety switch, to driven equipment, auxiliary contact to lock-out VFD from running when safety switch is open.

6. Network communications capability:
a. Provide VFD with communication card, protocol and required programming for digital communication of all VFD program and operational parameters to plant control system via:
1) Ethernet IP.
b. Refer to Specification Section 40 61 96 for additional requirements.

2.5 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a “dedicated system” in IEEE 519 Table 10.2.

B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from the utility, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).

1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
2. Current distortion: IEEE 519 Table 10.3 based on calculated I_{SC}/I_L at each PCC.

C. PCC shall be considered:

1. Building service entrance switchgear, switchboard or MCC.
2. Each MCC, switchboard, or panelboard supplying a VFD branch circuit.

D. The Engineer has performed preliminary calculations based on typical VFD data which indicate that the minimum mitigation measures required to meet the specified harmonic criteria are one of the following topologies:

1. 6-pulse rectifier topology.
2. 12-pulse rectifier topology for each VFDs.
3. 18-pulse rectifier topology for each VFDs.
4. Active filters or active front end rectifier topology for each VFDs.
5. Active harmonic filter (specified elsewhere) at each PCC.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. VFD manufacturer shall provide a harmonic analysis of the distribution system based on their proposed specific equipment characteristics and mitigation techniques confirming that the specified levels are not exceeded.

1. Analysis shall be based on the methodology of IEEE 519 and IEEE 399.
2. Power system data for analysis shall be taken from the electrical drawings and approved equipment submittals.
   a. VFDs provided in a package with equipment specified elsewhere, shall be included in the analysis.

G. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.

1. Values in excess of specified limits require correction by contractor and re-measurement.
2. Provide certification of compliant measurements as part of Field Service Engineer’s final report.

2.6 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

C. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.

1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:

a. Inverter duty motors: 1280 V.
b. Rise time shall be greater than or equal to 0.1 microsecond.
c. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors.

D. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10% shorter than the manufacturers published literature for maximum lead length for the type of cable installed.
1. Values in excess of specified limits require correction by contractor and re-measurement.
2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.7 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:
1. Each VFD system shall be factory-assembled in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.
2. Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Engineer's permission may be mounted in a separate enclosure.
3. Cooling fans, as required, shall be provided to run when drive is running.
4. Enclosures for separately mounted VFD's:
a. NEMA Type 1 for installation in Electrical Rooms.
b. NEMA Type 12 for installation in other unclassified areas.

B. Wiring:
1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
b. Bases with a self-sticking back will not be allowed.
2. All plug-in contacts shall be gold-plated.
3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
a. Provide terminals for shield continuity where required.
4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
a. Non-brittle, interlocking, track-mounted type.
b. Screw terminals will not be allowed.
c. A terminal for each conductor of external circuits plus one ground for each shielded cable.
d. For free-standing panels, 8 inches of clearance shall be provided between terminals and the panel base for conduit and wiring space.
e. Not less than 25% spare terminals shall be provided.
f. Terminals shall be labeled to agree with identification indicated on the suppliers submittal drawings.

g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
   a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
   a. Markings or color code shall match the manufacturer's drawings.
7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:
   1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 10 14 00.
   2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
   3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.8 COMPONENTS AND ACCESSORIES

A. Reactors:
   1. Impedance: As required.
   2. Continuous current: Not less than drive rating.
   3. Current overload: 150% for 1 minute.
   4. Insulation temperature rating: 180 degrees C.
   5. Copper windings.
   6. Saturation current rating: 3.5 to 5 times rated current.
   7. Hi-potential rating: 2500 VAC line to ground and line to line, for 1 minute.
   8. Noise reduction features:
      a. Epoxy over cast coil.
      b. Extra dips and bakes of varnish over continuous wound coil.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests:
   1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.

2.10 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).

B. Two (2) replacement/spare variable frequency drive motherboards.

C. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

B. Provide separately mounted VFD enclosure with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.

1. Determine the SCCR rating by one of the following methods:
   a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
   b. Method 2: SCCR rating meets or exceeds the source equipment’s Amp Interrupting Current (AIC) rating as indicated on the Drawings.
   c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

C. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.

D. Provide services of manufacturer's representative to perform start-up services.

E. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.

1. The space available on the Drawings shall not be exceeded.

3.2 START UP

A. Pre-start-up Services:

1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period described in Specification Section 01 75 00.
2. Shall consist of:
   a. Physical and electrical installation check.
   b. Final adjustments and calibration of drive parameters.
   c. VFD operation from simulated input signals.
3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:

1. Perform field measurement of harmonics at each PCC per Harmonic Protection Requirements Article.
   a. For each individual VFD.
   b. For the maximum number of VFDs that will be operational at the same time.
   c. When all loads are at 75% load minimum.
   d. Duration: 1 hour minimum.
2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per Motor Protection Requirements Article.
   a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
      1) Time shall be measured in microseconds.
   b. Tests shall be performed at full:
      1) Full voltage and speed.
      2) Loaded to 75% minimum.

3) Duration: 1 hour minimum.

3. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:

1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
   a. Perform all work in the presence of the Owner's designated representatives.
2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
   a. Ensure compatibility of VFD with associated control and instrumentation signals.
4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Instruct Owner's designated personnel:

1. Minimum of 8 hours at the jobsite.
2. Include both field and classroom instruction.
3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
   a. Lubrication.
   b. Troubleshooting.
   c. Repair and replacement.
   d. Parts inventory.
   e. Maintenance records.

3.3 SCHEDULES

A. Several motors may have full load amps (FLA) greater than that listed in NFPA 70.

1. The following table is an estimate for the FLA of the motors based on preliminary Shop Drawings.

EQUIPMENT TAG	HP	RPM	ESTIMATED FLA
FWZ2P-03002	400	1200	527
FWZ2P-03004	800	900	1137
FWZ2P-03005	800	900	1137
FWTP-03012	200	720	268
FWTP-03013	500	600	666
FWTP-03014	500	600	666
BWP-03016	200	600	337

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 01 77 19 –Closeout Requirements.

END OF SECTION

SECTION 26 32 15

ENGINE GENERATOR - LIQUID PROPANE GAS (LPG)

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Engine generator set and accessories.

B. Related Sections include but are not necessarily limited to:

1. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Environmental Protection Agency (EPA):
   a. 40 CFR 60, Standards of Performance for New Stationary Sources, New Source Performance Standards (NSPS):
      1) Subpart JJJJ, Standards of Performance for Stationary Spark Ignition Internal Combustion Engines.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. C57.16, Standard Requirements, Terminology, and Test Code for Dry-Type Air-Core Series-Connected Reactors.
3. National Electrical Manufacturers Association (NEMA):
   a. LA1, Surge Arresters.
   b. MG 1, Motors and Generators.
4. National Fire Protection association (NFPA):
   a. 70, National Electrical Code (NEC).
5. Society of Automotive Engineers (SAE).
6. Underwriters Laboratories, Inc. (UL):
   a. 142, Standard for Safety Steel Aboveground Tanks for Flammable and Combustible Liquids.
   b. 810, Standard for Capacitors.
   c. 2200, Standard for Stationary Engine Generator Assemblies.

B. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and installation of the generators and associated equipment.

1.3 SYSTEM DESCRIPTION

A. The engine generators will be used and rated for:

1. Optional standby power during a utility power outage, NFPA 70, Article 702.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Provide submittal data for all products specified in PART 2 of this Specification.
   b. See Specification Section 26 05 00 for additional requirements.
   c. Engine/generator performance curves.
   d. Manufacturer’s certification that engine meets exhaust emissions specified in PART 2 of this Specification.

2. Fabrication and/or layout drawings:
    a. Dimensional plan and elevation drawings.
    b. Wiring interconnection drawings.
3. Test reports:
    a. Factory test data.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
    a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Unit installation, startup, and operational statement.
2. Field Quality Control test reports.

1.5 SITE CONDITIONS

A. Ambient Air Temperature:

1. Minimum: 40 DEG F.
2. Maximum: 110 DEG F.

B. Altitude: 4500 feet above sea level.

C. Seismic (Earthquake) Forces:

1. S_{ds}: 0.40 g.
2. S_{d1}: 0.23 g.

PART 2 - SEISMIC DESIGN CATEGORY: B.PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Engine generator unit:
    a. Blue Star Power Systems.
    b. Caterpillar.
    c. Cummins.
    d. Kohler.
    e. MTU Onsite Energy.
    f. Taylor Power Systems.
2. Silencers:
    a. Manufacturer's standard.
3. Battery charger:
    a. Manufacturer's standard.
4. Governor:
    a. Manufacturer's standard.
5. Radiator:
    a. Manufacturer's standard.
6. Vibration isolators:
    a. Manufacturer's standard.

2.2 EQUIPMENT

A. Emissions Requirements:

1. A single units emissions shall meet all Federal, State and Local government requirements, including but not limited to:
    a. EPA NSPS 40 CFR 60, Subpart JJJJ.

B. Performance and Configuration Requirements:

1. The Unit shall be capable of providing standby power without over or under loading the Unit.
    a. Size the Unit for the following:
        1) Parameters:
            a) Maximum voltage dip: 5%.
            b) Maximum frequency dip: 10%.
        2) Loads:
            a) Step 1:
                (1) HVAC for Electrical Building
                (2) Rooftop Exhaust Fans (5)
                (3) Storage Room Exhaust Fan
                (4) Building 208Y/120V loads
    b. Deviations from the indicated size on the drawings based on the manufacturer's calculation shall be brought to the attention of the Engineer.

2.3 COMPONENTS

A. Engine Generator Unit General:

1. LPG piped from site storage tank to alternating current generator mounted on suitable rigid steel skid supports.
2. Mount unit on skid suitable for installation on concrete foundation.
3. Base rating on operation at rated RPM when equipped with all operating accessories.
4. Standards: UL 2200.

B. Engine:

1. Heavy duty, industrial, spark-ignited, water and fan cooled, turbocharged and aftercooled or innercooled, four-cycle engine.
2. Rotational speed: 1800 RPM.
3. Fuel supply: Propane.
4. Connecting rod:
    a. Use steel forging, angle-split for easy removal through cylinder liner.
    b. Serrated split line for precise cap alignment.
    c. Rifle drill for full pressure piston pin lubrication and piston crown cooling.
5. Crankcase:
    a. Provide rigid one piece ferrous alloy casting with integral cylinder frame.
    b. Vee angle of 60 degrees.
    c. Deep suction main bearing caps cross-tie bolted to crankcase for extra rigidity.
6. Crankshaft:
    a. Provide multi-plane forging of high alloy steel, with precision ground and hardened main bearing and crankpin journals.
    b. Dynamically balance.
    c. Provide generous overlap of main bearing and crankpin journals for increased crankshaft stiffness.
    d. Use large diameter main bearings with service rating.
7. Cylinder head:

a. One interchangeable deep suction casting for each cylinder.
b. Four overhead valves per cylinder; dual stellite-faced intake valves and dual stellite-faced inconel exhaust valves, 30 degrees angle seat.
    1) Solid stellite valve seat inserts.
c. Valve lifters with hydraulic push rods.
d. Valve guides of ferrous alloy.
    1) Alloy iron rocker arms.
e. Cylinder head gasket with laminated fire ring to seal combustion.
f. Mount each head casting rigidly to crankcase by minimum 1 inch diameter high strength steel alloy studs.

8. Cylinder liner: Removable wet type.
9. Flywheel housing: Provide SAE #00.
10. Oil pan:
    a. Provide base type with access openings to permit inspection, maintenance and removal of connecting rod and main bearings.
    b. Extend drain to edge of engine skid.
    c. Terminate with flanged ball valve.
11. Pistons: Provide heavy section contour ground oil cooled aluminum alloy with NI-resist top ring groove insert and floating piston pin.
12. Vibration damper: Provide viscous type, mounted at front end of crankshaft.
13. Air cleaner: Provide dry, panel type air cleaners with rain shield and service indicator.
14. Flywheel: Machine to suit requirements.
15. Pyrometer: Provide RTD on exhaust and indicate on engine mounted panel.
16. Capable of operating at idle or light loads for extended periods of time without deterioration.

C. Lubricating System:

1. Positive displacement, gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
2. Spray cool and lubricate pistons.
3. Oil filters so located that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
4. Filter elements accessible and easily removable.
5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
6. Equip filter system with spring-loaded by-pass valve.
7. Oil cooler: Water-cooled, engine-mounted.

D. Fuel System:

1. Single connection point.
2. Solenoid valve.
3. Gas will be provided via propane storage tank. Provide regulator as required.
4. Carburetor.

E. Governor:

1. Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1% of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing.

F. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.

G. Electric Starting System:

1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
2. Controls to provide automatic cranking of engine when generator is called to start.
3. Prevent excessive cranking which could damage cranking motor.
4. Automatic stop controls.
5. Starter motors with positive-engagement feature.

H. Cooling System:

1. Capacity for cooling engine at the specified operating and ambient conditions.
2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
3. Unit mounted radiator.
   a. Core guard flexible duct adapter.
   b. Site glass at top of unit.
   c. Engine driven blower fan.
   d. Low water level cutoff switch.
4. Provide fan guards.

I. Heater:

1. Thermostatically controlled jacket water heater to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
2. 480 V, single phase, up to 10 kW.
3. Set at 130 - 139 degrees F.

J. Silencer:

1. Suitable type for residential silencing.
2. Material: All stainless steel.

K. Flex Exhaust Connector:

1. Seamless, stainless steel, exhaust adapter for exhaust outlet to silencer.
2. Exhaust pipe fitted with a hinged stainless steel rain cap.

L. Exhaust System Insulation:

1. Rigid insulation: High temperature 3 inches calcium silicate type with aluminum jacket fastened with aluminum or stainless steel hardware.
2. Flexible insulation: High temperature fiberglass, 9 pound/CUFT.

M. Batteries:

1. Lead acid type.
2. Furnish electrolyte separately for use when installation is complete and unit is ready for testing.
3. Provide battery rack.

N. Battery Charger:

1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 VAC input.
3. Malfunction alarm contacts (minimum): Low and high battery voltage, weak battery and charger failure.
4. Mount on adjacent wall or support structure next to batteries.

O. Generator:

1. Brushless, 4 pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class F insulation, 4 wire, 0.8 power factor, 60 Hz, 480 V.
2. Minimum standby ratings:
   a. As indicated on the Drawings, substantiated by manufacturer's standard published curves and conform to NEMA MG 1.
   b. Special ratings or maximum ratings are not acceptable.
3. Rated to serve up to 50% non-linear load without exceeding rated temperature rise.
4. Maximum Harmonic Content: 5%
5. Minimum efficiency: 92% at 50 to 110% of nominal standby rating.
6. Less than 30% instantaneous voltage dip at full load and rated power factor and suitable for simultaneous operation with other units connected in parallel.
7. Stator and rotor: 130 DEGC temperature rise with minimum Class F insulated with 100% epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
8. Directly connect stator to engine flywheel housing.
9. Drive rotor through semiflexible driving flange to ensure permanent alignment.
10. Self ventilating with suitable blower, air inlet and outlet openings.
11. Generator drive free from critical torsional vibration within operating range.
12. Provide two RTD per phase in stator windings.
    a. Connect to Generator Protection relay.
13. Provide condensation heater.
14. Provide generator mounted main circuit breaker:
    a. Solid state molded case type.
    b. Ratings as indicated.

P. Voltage Regulator:

1. SCR type, to maintain 2% voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2%.
2. Automatic protection against short circuits on system.
   a. Provide 3.0 PU for 10 seconds.
3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
4. Provide voltage level and gain controls for normal operating adjustments.
5. Provide voltage level control with minimum range of ±5% from rated voltage.
6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.

Q. Generator Terminal Equipment:

1. Provide generator terminal equipment to house surge arrestors, surge capacitor, and current transformers as indicated on the Drawings.
   a. Free-standing enclosure with full height hinged, lockable door.
   b. Provide telescoping wireway or other flexible connection between alternator and terminal equipment enclosure to isolate vibration.
2. Surge arrestors:
   a. Comply with NEMA LA1 and IEEE C62.11.
   b. Designed for rotating machinery protection.
   c. Gapless metal oxide type.
   d. Porcelain or polymer housing with metal base.
   e. Intermediate class.

f. MCOV Rating: 10.2 kV.

3. Surge capacitor:
   a. Comply with UL 810.
   b. Three-phase, three-pole unit designed for rotating machinery protection.
   c. Porcelain bushings.
   d. Integral case ground terminal.
   e. Non-PCB impregnant.
   f. Low loss film dielectric.
   g. Internal discharge resistors.
   h. Ratings:
      1) Maximum voltage: 15,180 V line-to-line.
      2) 0.25 microfarads per pole.
4. Ground bus sized minimum 2 inches x 1/4 inches, copper, continuous through structures.
   a. Bond non-current carrying elements solidly to bus.
   b. Provisions for up to four lugs in each structure to terminate grounding related cables.

R. Engine Control Panel (located at or on genset):
1. Engine instruments:
   a. Fuel pressure gage.
   b. Oil pressure gage.
   c. Oil temperature gage.
   d. Water temperature gage.
   e. Run time meter.
   f. Battery voltage meter.
2. Automatic cycle cranking and over-crank protection.
3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.
4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.
5. Three Form C auxiliary contacts for interface with louvers, fans or other miscellaneous equipment.
   a. Contacts shall be connected in a fail-safe configuration.
6. Emergency stop.
7. Run time meter.
8. Minimum red shut down indicating lights as follows:
   a. Overcrank.
   b. Overspeed.
   c. Low lubricating oil pressure.
   d. High engine water temperature.
9. Minimum amber alarm indicator lights as follows:
   a. Control switch not in auto position.
   b. Low engine water temperature (less than 70 degrees F).
   c. Battery charger malfunctioning.
   d. Low battery voltage.
10. Minimum amber prealarm indicator lights as follows:
    a. High engine water temperature.

b. Low lubricating oil pressure.

S. Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the seismic zone of the Project.

2.4 SOURCE QUALITY CONTROL

A. Individually test each prime mover.

1. Apply derating factors for the proposed site to test data.
2. Continuously test for a period no less than 2 hours.
3. Test procedure shall be as follows:
   a. Start prime mover and upon reaching rated RPM, pick up 50% of nameplate KW rating at rated power factor in one step.
   b. Load rejection test.
   c. Observe and record the cranking time(s) required to start and run for each prime mover.
   d. Observe and record the time required to come up to operating speed for each prime mover.
   e. Record voltage and frequency overshoot for each prime mover.
   f. Record voltage, frequency and amperes.
   g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

2.5 MAINTENANCE MATERIALS

A. Spare Parts: Provide manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions.

B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 degrees F.

C. Install all wiring to engine in conduit. Control wiring on engine may be factory installed in high temperature loom.

D. Provide control wiring in conduit between generator control panel and remote devices as described under generator instrument and controls paragraph and remote annunciator paragraph of this Specification.

E. Mount on concrete pad utilizing vibration/seismic isolators, see structural drawings for pad detail.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by this Specification Section.
2. Supervise pre-startup adjustments and installation checks.
3. Conduct initial startup of equipment and perform operational checks.
4. Provide Owner written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
5. Provide 4 hours of the manufacturer's technical representative's time for on-site training of Owner's personnel.

B. Provide two load tests and one cycle crank tests.

1. Tests one and two shall be for continuous period of no less than 2 hours each.
    a. Engineer and Owner shall be notified 7 days prior to testing.
2. Test number one:
    a. With prime mover(s) in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to facility.
    b. Observe and record the time delay on engine start.
    c. Observe and record the cranking time(s) required to start and run for each prime mover.
    d. Observe and record the time required to come up to operating speed for each prime mover.
    e. Record voltage and frequency overshoot for each prime mover.
    f. Observe and record time required to achieve steady-state condition with all switches transferred to emergency position.
    g. Record voltage, frequency and amperes.
    h. Record oil pressure, water temperature where applicable and battery charge rate at 5 minute intervals for the first 15 minutes and at 15 minute intervals thereafter for each prime mover.
    i. Return normal power to facility, record time delay on retransfer to normal for each switch and cooldown time delay for each prime mover.
3. Test number two:
    a. Immediately after completion of test number one, start prime mover and upon reaching rated RPM, pick up 100% of nameplate KW rating in a maximum of three steps.
        1) Unity power factor is acceptable for on-site testing.
    b. Observe and record the cranking time(s) required to start and run for each prime mover.
    c. Observe and record the time required to come up to operating speed for each prime mover.
    d. Record voltage and frequency overshoot for each prime mover.
    e. Observe and record time required to achieve steady-state condition.
    f. Record voltage, frequency and amperes.
    g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.
4. Cycle crank test:
    a. Perform test for each prime mover.
        1) Utilize any method recommended by manufacturer to prevent prime mover(s) from running.
        2) Put control switch into "run" position to cause prime mover to crank.
    b. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration.
        1) Upon starting and running of the prime mover, further cranking shall cease.
        2) Two means of cranking termination shall be utilized so that one will act as a backup to the other to prevent inadvertent starter engagement.
        3) Cranking limiter time shall be 75 seconds for cycle crank.
5. Furnish load banks of required ratings necessary for tests.
    a. Unit will have lugs available for connection to the 480 V load side of the generator.
6. Record engine fuel consumption by means of test equipment.
7. Test all safeties specified for generator instruments and controls as recommended by manufacturer and as required to verify proper operation.
8. The Contractor shall be responsible for fuel and all consumables use during the test.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 77 19 – Closeout Requirements.

END OF SECTION

SECTION 26 50 00
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
   a. Interior building and exterior building mounted luminaires.
   b. Exterior and site luminaires.
   c. LEDs.
   d. Drivers.
   e. Light poles.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 03 - Concrete.
2. Section 26 05 00 - Electrical - Basic Requirements.
3. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI):
   a. C78.377, Specification for the Chromaticity of Solid State Lighting Products.
2. American Society of Mechanical Engineers (ASME):
   a. B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
   b. B18.5, Round Head Bolts (Inch Series).
3. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A194/A194M, Standard Specification for Carbon Steel, Allow Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   e. .
   f. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   g. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
   h. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   i. A635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
   j. F3125/F3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
4. Federal Communications Commission (FCC):

a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.

5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
6. Illuminating Engineering Society of North America (IESNA):
   a. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
   b. LM-80, Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
7. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
   c. LE 4, Recessed Luminaires, Ceiling Compatibility.
8. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
   a. SSL 1, Electronic Drivers for LED Devices, Arrays or Systems.
9. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 101, Life Safety Code.
10. Underwriters Laboratories, Inc. (UL):
    a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
    b. 924, Standard for Emergency Lighting and Power Equipment.
    c. 1012, Power Units Other Than Class 2.
    d. 1310, Standard for Class 2 Power Units.
    e. 1598, Luminaires.
    f. 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.
11. United States Department of Energy (USDOE):
    a. EPAct, the National Energy Policy Act.

1.3 DEFINITIONS

A. Useful Life for LED luminaire light sources:
   1. The operating hours before reaching 70% of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
   2. This is also known as 70% "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Identify luminaire by Luminaire Schedule designation.
      c. Luminaire data sheet:
         1) Name of manufacturer.
         2) Complete order information (catalog number).
         3) Description of construction and optics.
         4) Total input wattage.
         5) Luminous efficacy (lumens/Watt).
         6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.

7) Dimensional size.
8) Weight.
9) UL nameplate data for luminaires used in Class 1, Division 1 and 2 areas.
10) Effective Projected Areas (EPA) for pole mounted luminaires.

d. Solid state Luminaire additional data:
1) Voltage.
2) Initial and IES L70 lumens.
3) Luminous efficacy (lumens/Watt).
4) Correlated Color Temperature (CCT).
5) Color Rendering Index (CRI).
6) Total Harmonic Distortion (THD).
7) Lamp life.
8) Driver manufacturer and model number.
9) Driver life.
10) Driver type (0-10V, constant voltage, constant current).
11) Dimming range and control device compatibility.
12) Remote driver: Maximum wire length to luminaire.
13) Emergency battery driver:
a) Compatibility with lighting module.
b) Lumen output of lighting module in emergency operation.
c) Battery life.
d) Description of testing.
e) Ambient operating temperature.
14) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
15) DesignLights Consortium (DLC) Listing.
16) Warranty information.

e. Pole data sheet:
1) Name of manufacturer.
2) Complete order information (catalog number).
3) Description of construction.
4) Length, shaft size and thickness.
5) Wind loading (available luminaire EPA per wind speed).
6) Anchor bolt template.
7) Bolt size and material.

f. Photometric calculation for manufacturers not listed in the Luminaire Schedule:
1) Location: Per Table on the Drawings.
a) Calculation method: Zonal Cavity or Point-to-Point.
b) Required footcandle level: Per Table on the Drawings.
c) Light loss factor: 0.7 .

g. See Specification Section 26 05 00 for additional requirements.

2. Test Reports:
a. IESNA LM-79 Test Report for Solid-State Luminaire.
b. IESNA LM-80 Test Report Solid-State Light Source.

3. Certifications: Solid-state Luminaire Useful Life Certificate.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
b. Submittal data for each component covered by warranty.
c. Warranty.

1.5 WARRANTY

A. Minimum of a five year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15% of the individual light emitting diodes fail to illuminate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Luminaires: Per Luminaire Schedule or equal.
2. Solid State Light Sources:
a. Cree.
b. Xicato.
c. Luminaire manufacturer’s proprietary system.
3. LED Driver: Luminaire manufacturer's standard.
4.
5. Poles: Luminaire manufacturer's standard.

2.2 GENERAL REQUIREMENTS

A. Luminaires complete with LED modules and drivers.

B.

C. Provide all luminaires with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks.

D. No live parts normally exposed to contact.

E. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."

F. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable for wet locations."

2.3 LUMINAIRES

A. Standards and Listings:
1. DesignLights Consortium (DLC).
2. UL 1598.

B. Housings:
1. As indicated in the Luminaire Schedule and the following:
a. Troffer luminaires:
1) Minimum 22 gage sheet steel.
2) Integral end plates and trim flanges to suit ceiling construction.
3) Wire way covers with captive retainers to allow access to electrical components without use of tools.
b. Extruded aluminum housings, where scheduled, shall be at least 1/8 inches thick.
c. Punch and form housings prior to finishing (post-paint).

C. Castings:

1. As indicated in the Luminaire Schedule and the following:
   a. Uniform quality, free from imperfections affecting strength and appearance.
   b. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.

D. Fasteners:

1. As indicated in the Luminaire Schedule and the following:
   a. Aluminum or steel luminaires: Zinc-Nickel plated, stainless steel, or equivalent.
   b. Stainless steel luminaires: Stainless steel.
   c. Bronze luminaires: Bronze or stainless steel.
   d. Non-metallic luminaires: Stainless steel.

E. Finishes:

1. As indicated in the Luminaire Schedule and the following:
   a. Painted surfaces:
      1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish, acrylic, alkyd, epoxy, polyester, or polyurethane.
      2) White finishes shall have minimum 85% reflectance.
   b. Unpainted surfaces:
      1) Interior: Clear anodic coating, satin finish.
      2) Exterior: Clear anodic coating.

F. Lens/Louver Frames:

1. As indicated in the Luminaire Schedule and the following:
   a. Extruded aluminum with mitered corners.
   b. Hinging or other normal motion shall not cause lens or louver to drop out.
   c. No light leak between frame and housing.

G. Lenses:

1. As Indicated in the Luminaire Schedule and the Following:
   a. 100% virgin, UV stabilized acrylic.
   b. Held securely in place but must also be removable for cleaning and servicing.
   c. Luminaires with directional lenses shall include a lens orientation device to ensure that lens installation provides light distribution as designed.
   d. No light leaks between the lens and the luminaire.

H. Reflectors:

1. As Indicated in the Luminaire Schedule and the Following:
   a. Troffer reflector finish: Integral reflectors shall be painted white after fabrication with a minimum reflectance value of 90%.

I. Gaskets:

1. As Indicated in the Luminaire Schedule and the Following:
   a. Gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and allow interior access.
   b. Moisture seal gaskets at exterior locations and in other designated wet areas.
   c. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks.

J. Ventilation:

1. Ventilation openings of adequate size and quantity to permit operation of driver without affecting rated output or life expectancy. Include wire mesh screens.

K. Wiring:

1. Factory-wired to be compatible with the project electrical and controls systems.

L. Mounting Accessories:

1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not affected during servicing or cleaning.
3. Luminaire Suspension Material:
   a. Unfinished Spaces:
      1) 1/2 inches minimum diameter swivel stem, unless otherwise noted.
      2) Safety chain on high bay type.
      3) Coordinate pendant location with mechanical ductwork.
         a) Submit coordinated mounting accessories as part of Shop Drawing submission.

2.4 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

A. Standards:

1. IESNA LM-79, IESNA LM-80.
2. NEMA SSL 1.
3. UL 1012, 1310, and 8750.

B. Solid state modules and driver to be provided and warrantied by luminaire manufacturer.

C. Solid-State Modules:

1. Uniform color temperature of 4000K unless otherwise noted on the Luminaire schedule.
   a. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types (ANSI C78.377).
2. Minimum color rendering index (CRI) of 80.
3. LED module light output and efficacy: Measured in accordance with IESNA LM-79 standards.
4. LED useful life and lumen maintenance: Measured in accordance with IESNA LM-80 standards.
5. Driver and LED module: Minimum useful life of 50,000 hours (L70).
6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

D. Driver:

1. Compatible with solid-state modules and control devices specified.
2. Operate from 60 Hz input source of 120V through 277V with sustained variations of ±10% (voltage and frequency).
3. Input current Total Harmonic Distortion (THD): Less than 20% when operated at nominal line voltage.
4. Power Factor: Greater than 0.90.
5. Avoid interference with infrared devices and eliminate visible flicker.
6. Comply with ANSI C62.41 Category A for Transient protection.
7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

8. Dimmable drivers capable of continuous dimming over a range of 100% to 10% of rated lumen output, unless otherwise specified in Luminaire Schedule. Dimming controlled by a 0 - 10 VDC signal, unless otherwise specified in Luminaire Schedule.
9. Control device must be compatible with type of driver and coordinated prior to submission of Shop Drawings. List of compatible dimming controllers must include the range of perceived brightness. No visible flicker throughout the dimming range.
10. Remote-mounting:
    a. Provide maximum allowable distances for secondary wire runs to luminaires.
    b. Provide remote mounting hardware and enclosures as required.
11. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

E. Emergency Battery Driver:
1. UL 924.
2. Confirm compatibility with LED modules utilized.
3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger, and electronic circuitry.
4. A solid state charging indicator light to monitor the charger and battery.
5. Single-pole test switch.
6. The following product family shall be selected based on coordination with LED lamp type:
    a. Philips Bodine “BSL23C”: can operate up to 4.5W at 410mA.
    b. Philips Bodine “BSL26C”: can operate up to 5.1W at 265mA.
    c. Philips Bodine “BSL722 inches: can operate up to 23W at 770mA.
    d. Philips Bodine “BSL23C”: can operate up to 23W at 770mA in operating conditions ranging from -20 degrees C (-4 degrees F) to 60 degrees C (140 degrees F).
    e. Alternate manufacturer: Iota.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.
1. Provide ambient operating temperature range for which product is warrantied.

2.5 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

A. Standards:
1. UL 924.
2. NFPA 101.
3. Local State or City requirements.

B. Exit Signs:
1. Housing and finish: As indicated in the Luminaire Schedule.
2. LED illuminated with integral driver.
3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
4. Battery powered units:
    a. Battery type: As indicated in the Luminaire Schedule.
    b. Self-testing/self-diagnostic.
        1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
    c. Consist of battery, charger, and electronic circuitry.
    d. Solid state charging indicator light to monitor the charger and battery.
    e. Single-pole test switch.
    f. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

C. Emergency Lighting Units:

1. Housing: As indicated in the Luminaire Schedule.
2. Lamps: As indicated in the Luminaire Schedule.
3. Battery type: As indicated in the Luminaire Schedule.
4. Self-testing/self-diagnostic.
   a. Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
5. Consist of battery, charger, and electronic circuitry.
6. Solid state charging indicator light to monitor the charger and battery.
7. Single-pole test switch.
8. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

2.6 POLES

A. As Indicated in the Luminaire Schedule and the Following:

1. Designed for attached luminaire EPA with a 100 MPH maximum wind velocity at the base with a 1.3 wind gust factor.
2. Additional features:
   a. Handhole near base of pole.
   b. Grounding lug accessible at handhole.
   c. Galvanized anchor bolts.
   d. Anchor bolt covers.
   e. Vibration dampener(s).

2.7 POWER INSTALLED POLE FOUNDATION ANCHORS

A. Consists of steel screw anchors with one or more helix-shaped steel plates attached to a central steel tube to resist bending moments and installation torque.

B. Foundation anchors shall be designed by a designer employed by the anchor manufacturer.

1. Comply with the following requirements:
   a. Pole and luminaire properties: Per actual pole and luminaire to be installed.
   b. Wind velocity: 100 MPH with a 1.3 gust factor.
   c. Soil classification: Refer to Geotechnical Report for soil classification.

C. Component Materials:

1. Material finish: Hot-dip galvanized per ASTM A153/A153M.
2. Baseplate: ASTM A36/A36M structural steel (conform to AASHTO Technical Bulletin No. 270).
3. Shaft: ASTM A252, Grade 2, steel pipe piles or alternate ASTM A53/A53M Type E or S, Grade B, steel pipe, ASTM A500/A500M, Grade B, structural steel tubing.
4. Helix: ASTM A635/A635M hot rolled steel.
5. Pilot point: ASTM A575 steel bar.
6. Bolts: Carriage bolt per ASME B18.5 round head bolts, SAE J429, Grade 5.
7. Nuts: Heavy hex in per ASME B18.2.2 and ASTM F3125/F3125M or ASTM A194/A194M, Grade 2H.

2.8 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10% of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10% of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate Luminaire Types with Ceiling Construction:

1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.

B. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.

1. Do not support luminaire from conduit system.
2. When luminaire is supported from outlet boxes, install per NFPA 70.
3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.

C. Support surface mounted luminaires from the building structure.

1. Luminaires up to 4 feet wide and 4 feet long: A minimum of four supporting points, one at each corner.
2. Luminaires 8 feet long: A minimum of five support points, one at center of luminaire and one at each corner.
3. Luminaires smaller than 2 feet in length: A minimum of two supporting points.

D. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.

1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.

E. Pendant Mounted, Open, Industrial Luminaire:

1. Not in continuous rows:
   a. Supported by conduit or by approved chains or cable:
   b. Hardwired to ceiling mounted junction box.

F. Mount luminaire at heights indicated in Specification Section 26 05 00 or per Luminaire Schedule or as indicted on the Drawings.

G. Install exterior luminaires so that water cannot enter or accumulate in the wiring compartment.

H. Ground luminaire.

3.2 POLE INSTALLATION

A. Drawings Indicate the Intended Location of Light Pole:

1. Field conditions may affect actual location.
2. Coordinate location with all existing or new utilities and pavement.

B. Anchor Base Plated Poles:

1. Mounted on cast-in-place foundations, as detailed on the Drawings.
   a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.
   b. Concrete:
      1) Minimum compressive strength: 4000 psi at 28 days.
      2) Concrete work in accordance with ACI 301.
   c. Reinforcing steel:
      1) ASTM A615/A615M, Grade 60.
2. Mount on power installed pole foundation anchor.
   a. Anchor base plate to be approximately 2 inches above final grade.

3. Protect pole finish during installation.
    a. Repair damage to pole finish with manufacturer approved repair kit.

C. Ground poles as indicated on the Drawings.

D. Conductors:

1. See Specification Section 26 05 19 for required underground conductors.
2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to luminaire, #12 AWG minimum.

E. Overcurrent and Short Circuit Protection:

1. Protect each phase with a UL Class CC fuse:
    a. Size: Three times load current.
    b. Standard: UL 248-4.
2. Fuseholder:
    a. Watertight, in-line and break-a-way style.
    b. Accept up to a 30 A, 600 V fuse.
    c. Neutral conductor shall utilize a fuseholder with a solid copper rod.
    d. Conductor terminal: Adequate size for the installed conductors.

3.3 LIGHTING CONTROL

A. See Specification Section 26 20 00 for lighting control equipment.

B. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

3.4 ADJUST AND CLEAN

A. See Specification Section 01 74 00.

B. Replace all inoperable lamps with new lamps prior to final acceptance.

C. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION

DIVISION 31

EARTHWORK

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SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Site clearing Work, including:
   a. General provisions for site clearing Work.
   b. Preparation for site clearing Work.
   c. Clearing and grubbing.
   d. Disposal and cleaning.
   e. Stripping and stockpiling of topsoil.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 02 41 00 - Demolition.
2. Section 31 23 05 - Excavation and Fill.
3. Section 31 23 33 - Trenching and Backfilling.

1.2 REFERENCES

A. Terminology:

1. Terms indicated below are not defined terms indicated with initial capital letters but, when used in this Section, have the meanings indicated below:
   a. “Arborist” means Subcontractor retained to perform Work requiring a specialist in trees, shrubs, brush, other vegetation of the types existing at the Site, and possessing not less than the required qualifications indicated in this Section.
   b. “Clearing and grubbing” means removing and disposing of all: (1) trees, brush, and other vegetation, logs, and similar items (“clearing”); and (2) stumps, roots, logs, rubbish, and debris on or in the soil (“grubbing”) after Clearing. Clearing and grubbing includes grinding and removing of stumps. When clearing and grubbing, topsoil stripping and stockpiling, and required demolition Work is complete, the Site will be ready for grading and other new construction.
   c. “Demolition” means removal, whether in whole or in part, of existing human-made construction, such as removal of buildings, structures, and building systems; site work (such as pavement, curbs, sidewalks, gutters) and the like; Underground Facilities; and other existing construction.
   d. “Selective removal” means removal of specific trees, shrubs, brush, and other vegetation, whether as shown or indicated in the Contract Documents or as directed at the Site by Engineer.
   e. “Selective trimming” means removal of selected parts of trees, shrubs, brush, and other vegetation, performed by arborist, for the purpose of either: (1) allowing installation of new construction adjacent to or through the tree, shrub, brush, or vegetation, or)2) removing damaged or unhealthy growth, to allow balance of the subject tree, shrub, brush, or vegetation to continue normal, healthy growth.
   f. “Site clearing” means all the Work required by this Section and related Drawings.
   g. “Topsoil” means existing material at the Site, visible after clearing and grubbing, to be stripped, when such material is friable, clay loam, surface soil present in depth of not less than four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material. Topsoil required for planting and landscaping Work in the Specifications of Division 32 may differ from the meaning indicated in this Section.

B. Reference Standards:

1. ASTM International (ASTM):
   a. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   b. D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
2. American National Standards Institute (ANSI):.
   a. A300, Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices.
3. International Society of Arboriculture (ISA):
   a. Container Rootball Shaving.
   b. Crown Correction.
   c. Balled and Burlapped Root Correction.
   d. Container Root Correction.
   e. High Branched Crown Observation.
   f. Low Branched Crown Observation.
   g. Multiple Low Branches Crown Observation.
   h. Balled and Burlapped Root Observation.
   i. Container Root Observation - Tree.
   j. Protection Maintenance.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Pre-Clearing Conference:

1. Prior to commencing site clearing Work, actively participate in conference regarding site clearing Work. Date and time of conference will be mutually established by Contractor and Engineer.
2. Location: Conference will be held onsite..
3. Participants:
   a. Required Participants: Contractor's project manager, Contractor's site superintendent, arborist, Engineer , Owner's Site Representative.
   b. Potential Participants: Owner, facility manager (if applicable), and representative of properties (other than Owner) affected by site clearing Work,
4. Engineer will chair the conference, prepare and distribute an agenda, and prepare and distribute a record of the conference.
5. Participants shall be prepared to discuss:
   a. Project requirements and the Contract requirements for site clearing Work.
   b. Submittals required for site clearing Work.
   c. Schedule for site clearing Work and availability of resources.
   d. Locations and types of site clearing Work, with specific attention to areas of selective removals, selective trimming, and notable species. Limits of clearing and grubbing. Proposed locations for stockpiles and temporary storage of cuttings and debris.
   e. Environmental and other conditions at the Site.
   f. Growth, vegetation, and existing construction requiring protection.
   g. Required observations and field quality control for site clearing Work.
6. If additional information affecting site clearing Work subsequently comes to light, reconvene the conference at earliest opportunity.

1.4 QUALITY ASSURANCE

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
    a. Limits of Site Clearing Work: When limits of site clearing Work are not expressly shown on the Drawings, or where Contractor proposes alternative limits of site clearing Work, submit drawings, developed from the Drawings, clearly indicating proposed limits of site clearing Work, with dimensions indicated where appropriate.
    b. Where proposed limits of clearing and grubbing, selective removals, and topsoil stripping are not identical with each other, clearly and expressly indicate limits of each on the Shop Drawings.

B. Informational Submittals: Submit the following:

1. Permits and Approvals:
    a. Submit copy of each permit required and obtained for site clearing Work, issued by authority having jurisdiction.
    b. Where Owner's permission or approval is required for selected site clearing activities, submit copy of Owner's written permission or approval for such activity.
    c. When approval of owner of property (other than Owner) is required for selected site clearing activity, submit to Engineer written copy of such approval.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter Fabric:

1. In accordance with requirements for temporary erosion and sediment controls indicated in Section 01 57 05 - Temporary Controls.

B. Drainage Fill:

1. Selected crushed stone, or crushed or uncrushed gravel, washed.
2. Size 24 (in accordance with ASTM D448), with 90 to 100 percent passing 2.5-inch sieve and not more than 10 percent passing 3/4-inch sieve.

C. Burlap:

1. Jute, not less than 7.2 ounces per square yard.

D. For other materials needed for site clearing Work, such as stone, topsoil, or other, comply with requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 SITE CLEARING – GENERAL

A. Limits of Site Clearing Work:

1. Limits of site clearing Work are shown and indicated on the Drawings.

B. General Provisions for Site Clearing:

1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to perform site clearing Work in accordance with the Contract Documents.
2. Perform site clearing Work to avoid creating nuisances, pollution, and preventable adverse effects on the environment.
3. Comply with Section 01 71 33 - Protection of the Work and Property, and this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".
4. Excavation required for site clearing shall comply with Section 31 23 05 - Excavation and Fill.
5. Requirements of Authorities Having Jurisdiction:
    a. Perform site clearing Work in accordance with Laws and Regulations.

b. Obtain, pay for, and comply with permits required for site clearing Work. Obtain from authorities having jurisdiction and furnish copy of each permit as a Submittal.

6. Reference Points:
   a. Protect property monuments and other surveyor-established markers and staking.
   b. When disturbed by Contractor, retain qualified, properly licensed professional land surveyor to replace such monuments and stakes moved or removed by Contractor.
7. Site clearing Work shall comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article, unless the Contract Documents indicate more-stringent requirements.
8. Demolition Work is indicated in Section 02 41 00 - Demolition, including removal of site improvements and Underground Facilities.

3.2 PREPARATION

A. Permits and Approvals:
   1. Do not commence site clearing Work until necessary permits and approvals are obtained and copies furnished to Engineer as Submittals.

B. Delineation of Limits of Site Clearing Work Areas:
   1. Locate and clearly flag at the Site:
      a. Limits of site clearing Work.
      b. Trees, shrubs, vegetation, and other materials to remain within limits of site clearing Work.
      c. Trees, shrubs, and other vegetation to be selectively trimmed.
      d. Trees, shrubs, and vegetation to be selectively removed.
      e. Salvageable trees, shrubs, and vegetation (to be relocated) within limits of site clearing Work.
   2. Flagging:
      a. Flagging shall be high-visibility type. Where necessary, provide lath or stakes driven into the ground, with flagging, to clearly delineate limits.
      b. Provide different-colored flagging for each type of delineation required by this Article.
      c. Promptly replace lost, moved, or destroyed flagging until Engineer concurs that flagging is no longer needed.
   3. Review with Engineer:
      a. Before starting site clearing Work, other than flagging, review at the Site with Engineer.
      b. Make corrections as necessary.

C. Protection: Establish protection of trees, shrubs, and vegetation to remain, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming", and other applicable provisions of the Contract Documents.

D. Temporary Erosion and Sediment Controls:
   1. Provide applicable temporary erosion and sediment controls before commencing clearing and grubbing and topsoil stripping Work.
   2. Comply with temporary erosion and sediment control requirements of Section 01 57 05 - Temporary Controls.
   3. Continue providing temporary erosion and sediment controls as clearing and grubbing and topsoil stripping and stockpiling Work progresses into previously uncleared, ungrubbed areas of the Site.

3.3 CLEARING AND GRUBBING

A. Clearing and Grubbing – General:

1. Remove and dispose of all materials constituting clearing and grubbing Work within limits shown and indicated in the Contract Documents.
2. After grubbing Work is complete, properly fill holes resulting from grubbing before commencing site grading Work.

3.4 DISPOSAL AND CLEANING

A. Disposal – General:

1. Dispose of matter resulting from clearing and grubbing, selective removals, and selective trimming, at appropriate offsite location, unless otherwise expressly allowed by the Contract Documents or mutual agreement of Owner and Contractor.
2. Do not use cleared, grubbed, or trimmed material as fill, backfill, or in embankments.
3. Dispose of cleared, grubbed, and trimmed material, and other materials, rubbish, and debris, in accordance with Laws and Regulations.
4. Pay all costs associated with transporting and disposing of materials and debris resulting from site clearing Work.

B. Cleaning:

1. Perform progress cleaning and other cleaning Work, and disposal of resulting materials and debris, in accordance with Section 01 74 00 - Cleaning.

C. Burning:

1. Burning of trees, shrubs, brush, other vegetation, and other materials at, or adjacent to, the Site, whether in-place or cut, is prohibited.

3.5 TOPSOIL STRIPPING AND STOCKPILING

A. Stripping:

1. Before commencing topsoil stripping:
   a. Perform clearing and grubbing and selective removals.
   b. Remove grass and other vegetation that may remain following clearing and grubbing.
   c. Provide necessary and required temporary erosion and sediment controls.
2. Areas to be developed or graded should be cleared of surface and subsurface deleterious matter including any debris, brush, and associated stumps and roots. Graded areas should be stripped of organic soils. Based on our site observations, we estimate that stripping depths will typically be on the order of 8 to 12 inches to remove the rooted layer. Deeper stripping and grubbing depths will be required to remove localized deeper deposits of topsoil.
3. The organic soils can be stockpiled and processed for landscaping purposes or may be spread over disturbed areas following completion of grading. If spread out, the organic strippings should be placed in a layer less than 1-foot thick, should not be placed on slopes greater than 3H:1V, and should be track-walked to a uniformly compacted condition. Materials that cannot be used for landscaping or protection of disturbed areas should be removed from the project site.

B. Stockpiling:

1. Construct and maintain topsoil stockpiles within the staging area identified in the contract documents.

C. Reuse of Stripped Topsoil:

1. Reuse in the finish grading and landscaping Work topsoil that complies with the Contract Documents for such Work.
2. Where topsoil stripped from the Site does not comply with the Contract Documents relative to quality required for use in finish grading and landscaping Work, provide appropriate soil amendment material, properly and fully mixed into topsoil stripped from the Site, so that

amended material complies with quality requirements for topsoil required for finish grading and landscaping Work.

D. Disposal of Excess Topsoil:

1. Topsoil in excess of quantity required for finished Project becomes Contractor's property when Engineer indicates finish grading and landscaping Work is complete. Properly dispose of excess topsoil offsite. Contractor may sell excess topsoil at offsite location.

END OF SECTION

SECTION 31 22 19
FINISH GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Topsoil quality and placing.
2. Finish grading.

B. Related Requirements: Include, but are not necessarily limited to, the following:

1. Section 31 10 00 - Site Clearing.
2. Section 31 23 05 - Excavation and Fill.
3. Section 31 23 33 - Trenching and Backfilling.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:

1. Perform the Work of this Section for all areas within limits of grading and all areas outside limits of grading disturbed during construction.
2. Perform the Work of this Section as part of the Lump Sum bid/pay item(s) indicated in the Contract.

1.3 REFERENCES

A. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T194, Standard Method of Test for Determination of Organic Content of Soils by Loss on Ignition.
2. ASTM International (ASTM):
   a. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   b. D4221, Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer.
   c. D4972, Standard Test Methods for pH of Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping and Construction Purposes.
   e. D6913, Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
   f. D7928, Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.
   g. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Contractor's Testing Laboratory:
   a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of materials specified in this Section.
   b. When Contractor is expressly required, by this Section's "Quality Assurance" Article, "Source Quality Control" Article or elsewhere in the Contract Documents, to retain testing laboratory for tests required under this Section's "Quality Assurance" Article or

"Source Quality Control" Article, retain one testing laboratory for quality assurance testing and field quality control testing.

c. Testing laboratory shall comply with ASTM E329.

d. Testing laboratory shall be experienced in the types of testing required.

e. Selection of testing laboratory is subject to Engineer's acceptance. Upon Engineer's request, submit qualifications statement for testing laboratory, including name of entity, location, copies of applicable certifications, summary of entity's experience, and names and qualifications of personnel who will perform the subject sampling and testing.

B. Quality Assurance Testing:

1. Quality assurance testing, which may also be regarded as source quality control testing when topsoil to be installed will be topsoil originally stripped from the Site, is in addition to field quality control activities required by this Section's "Field Quality Control" Article.

2. Allow free access to material stockpiles and borrow areas at all times. Tests shall be at Contractor's cost.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:

a. Borrow Soil Materials: Name and address of Supplier of borrow soil materials, gradation, and Supplier's certification that materials are sufficiently free of Constituents of Concern so that a Hazardous Environmental Condition will not be created or exacerbated.

b. If no soil materials will be obtained from any borrow location, expressly so indicate to Engineer in writing.

2. Samples:

a. Submit Sample of topsoil material required by this Section. Furnish Samples in durable, tightly-sealed containers; plastic bags are unacceptable. Samples shall be of sufficient quantity and material size to demonstrate the array of gradation and material types expected in the Work.

B. Informational Submittals: Submit the following:

1. Quality Assurance Test Results Submittals:

a. Submit results of quality assurance testing performed in accordance with this Section's "Quality Assurance" Article, unless included as part of another submittal under this Section.

1) Tests on materials from onsite and borrow sources.

2. Qualifications Statements:

a. Quality assurance testing laboratory, when requested by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:

1. All soil accepted as topsoil, whether obtained from onsite or offsite sources, shall comply with requirements of this Section.

2. Topsoil Source: Reuse surface soil stockpiled on Site, where possible. Verify suitability of stockpiled surface soil to produce topsoil, as specified. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

3. Provide fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than 3/8 inch diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D 5268.

4. Provide topsoil of the following characteristics:
   a. Required gradation:

Sieve Size	Percent Passing
3/4 inch mesh	100
No. 4-sieve	90 to 100
No. 200-sieve	0 to 10

   b. Clay content of material passing No. 200-sieve shall be not greater than 60 percent, as determined by hydrometer tests.
   c. pH-adjusted with ferrous sulphate or ground limestone to provide pH 5.5 to 7.0 at time of installation of lawns and meadow areas, unless particular species of planting requires a different pH for optimal growth.
   d. Electrical conductivity of a 1:2 soil-water suspension shall not exceed 1.0 milliohm per centimeter and with less than 200 parts per million of extractable aluminum.
   e. Cation Exchange Capacity: 5, minimum.
   f. Organic content not less than five percent, as determined by ignition loss of oven-dried samples passing No. 10-sieve (Muffle Furnace Temperature: 110 plus or minus five degrees C for eight hours).
   g. Free of pests and pest larvae.
   h. Relative to Constituents of Concern, topsoil shall be in accordance with Laws and Regulations. Constituents of Concern, if any, in topsoil furnished shall not constitute or result in a Hazardous Environmental Condition.

2.2 SOURCE QUALITY CONTROL

A. Tests and Inspections at Source of Supply:
   1. Perform quality assurance testing, and submit results to Engineer, in accordance with the “Quality Assurance” Article in Part 1 of this Section.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-place Conditions:
   1. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing plants from damage caused by finish grading.

B. Preparation – General:
   1. In accordance with Section 01 57 05 - Temporary Controls, provide temporary measures for controlling erosion and sedimentation, airborne dust, and fugitive dust emissions from the Site.
   2. Topsoil stripping and stockpiling requirements are indicated in Section 31 10 00 - Site Clearing.
   3. Adjust rough grading to within 0.1 foot of required elevations. Properly compact sub-grades. Rough grading shall provide for appropriate drainage in accordance with the Contract Documents.
   4. Before applying topsoil:
      a. Remove from exposed subgrade all stones and debris over one inches in any dimension and properly dispose of such items at an appropriate, offsite location.
      b. Apply superphosphate fertilizer directly to subgrade before loosening.
      c. Loosen sub-grade surface to depth of not less than two inches.

3.2 INSTALLATION

A. Installation Requirements:

1. Required Depth of Topsoil:
   a. For areas of shrubs and similar plantings, provide finished, lightly compacted, topsoil depth of not less than 6 inches.
   b. For all other areas requiring topsoil, including lawns and meadows, provide finished, lightly compacted, topsoil depth of not less than 4 inches.
2. Do not place topsoil when subgrade is muddy, wet or frozen enough to cause clodding.
3. Provide finished surface smooth and true to required grades, in accordance with this Article's "Installation Tolerances" provision. Provide finished surface of topsoil equal to required finished elevations after light rolling and natural settlement.
4. Grade topsoil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to provide required finish grades.
5. Restore topsoil if eroded or otherwise disturbed after finish grading and before planting.
6. Topsoil Quantity Differentials:
   a. If quantity of required topsoil exceeds the quantity, if any, of topsoil stockpiled at the Site and available for use by Contractor, provide the additional required quantity from appropriate offsite borrow sources at no additional cost to Owner.
   b. When quantity of topsoil obtained from offsite borrow sources exceeds the required quantity of topsoil, remove excess from the Site, unless Owner allows such excess to be stockpiled at an appropriate location at the Site.
   c. When quantity of required topsoil is less than quantity of onsite stockpiles, following installation of topsoil, properly grade remaining stockpile for appropriate drainage without undue erosion and seed stockpile as required for other areas of lawn restoration in accordance with the Contract Documents.

B. Installation Tolerances:

1. Finish Grading Tolerance: ±0.1 foot from finish elevation required by the Contract Documents. Ensure adequate drainage.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Upon completion of topsoil installation, obtain Engineer's concurrence regarding grades and drainage.

3.4 PROTECTION

A. Commencing immediately after topsoil installation, protect installed topsoil from erosion and damage from other causes, including personnel, vehicles, and equipment. Promptly perform seeding, sodding (as applicable), mulching, and other measures to permanently stabilize soils and prevent erosion.

END OF SECTION

SECTION 31 23 05
EXCAVATION AND FILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for excavating, filling, and other earth Work, including:
   a. Field conditions.
   b. Soil and aggregate materials.
   c. Test pits.
   d. Excavation.
   e. Preparation of subgrades.
   f. Filling and compacting.
   g. Rough grading.
   h. Disposal of excavated spoil materials.

B. Related Requirements Include, but are not necessarily limited to, the following:

1. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
2. Section 31 10 00 - Site Clearing.
3. Section 31 22 19 - Finish Grading.
4. Geotechnical Engineering Report prepared by Ciani & Hatch Engineering, dated April 21, 2025.

1.2 PRICE AND PAYMENT PROCEDURESL

A. Measurement:

1. Contractor shall provide all labor, materials, construction equipment and machinery, tools, and incidentals required or necessary for performing all excavation and fill Work for the Contract, including all Work related to excavating, preparing subgrades, providing and stockpiling materials, filling with required materials, compacting, grading, proper disposal of excess spoil materials, and all other Work required by this Section. This Section includes excavation and fill Work required for constructing: structures; site improvements (including pavement, sidewalks, curbs, and the like); Underground Facilities; subgrade preparation for other Work; and all other excavation and fill Work required by the Contract Documents and not addressed under other Specifications sections.
2. Unless expressly indicated otherwise in the Contract Documents, such as Section 01 22 00 - Measurement and Payment, the Work of this Section is included in the various lump sum and unit price bid/pay items for the Contract.
3. All Work under this Section is unclassified and covered by this Section and the associated bid/payment item(s). No separate payment will be made for removing, handling, or disposing of rock (unless the Contract includes a separate bid/pay item specifically for rock excavation or rock removal), stones, concrete (whether or not reinforced), debris, stumps, and other material, regardless of moisture content, unless such material constitutes an unforeseen Hazardous Environmental Condition and Work associated with such Hazardous Environmental Condition is not included in the Contract.

1.3 REFERENCES

A. Terminology:

1. See Geotechnical Engineering Report.

B. Reference Standards: See Geotechnical Engineering Report for Additional Reference Standards. Standards referenced in this section include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. AMRL R18 - AASHTO Accreditation Procedure Manual.
2. ASTM International (ASTM):
   a. C33/C33M - Standard Specification for Concrete Aggregates.
   b. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   c. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
   d. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   e. D2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.
   f. D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   g. D2434 - Standard Test Methods for Measurement of Hydraulic Conductivity of Coarse-Grained Soils.
   h. D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   i. D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.
   j. D3740 - Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
   k. D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   l. D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   m. D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   n. D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
   o. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
   p. D7928 - Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.
   q. E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Applicable construction codes including building code are indicated in Section 01 42 00 - References.

B. Qualifications:

1. Contractor's Testing Laboratory:
   a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of materials specified in this Section.
   b. When Contractor is expressly required, by this Section's "Field Quality Control" Article or elsewhere in the Contract Documents, to retain testing laboratory for tests required

under this Section's "Field Quality Control" Article, retain one testing laboratory for quality assurance testing and field quality control testing.

c. Retain testing laboratory different from testing laboratory and special inspectors retained by Owner or Owner's consultant for code-required tests and special inspections for the Project, if any.

d. Testing laboratory shall possess current, valid accreditation from the AASHTO Materials Reference Laboratory (AMRL), in accordance with AASHTO AMRL R18, for ASTM D3740, for tests required for quality assurance testing indicated in this Article and field quality control testing indicated to be Contractor's responsibility.

e. Testing laboratory shall comply with ASTM E329.

f. Testing laboratory shall be experienced in the types of testing required.

g. Selection of testing laboratory is subject to Engineer's acceptance. Upon Engineer's request, submit qualifications statement for testing laboratory, including name of entity, location, copies of applicable certifications, summary of entity's experience, and names and qualifications of personnel who will perform the subject sampling and testing.

C. Quality Assurance Testing:

1. Quality assurance testing, which may also be regarded as source quality control testing, is in addition to field quality control testing required by this Section's "Field Quality Control" Article.

2. Materials used in the Work may require testing and retesting, as directed by Engineer, during the Project. Allow free access to onsite material stockpiles, borrow sources, and other sources of aggregate and soil materials at all times. Tests not specifically indicated to be performed at Owner's expense, including retesting of defective materials and defective Work, shall be at Contractor's cost.

3. Contractor's Testing Laboratory Scope:

a. Obtain samples and perform testing of proposed fill materials in the laboratory, at the Site, and at borrow locations (if any) to provide assurance that the Work will comply with the Contract Documents.

b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.

c. Submit to Engineer, via Contractor, written results of each test.

4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:

a. Perform the following quality assurance tests on materials to be incorporated into the Work. Submit results of such tests to Engineer and obtain Engineer's acceptance thereof prior to incorporating the subject materials into the Work.

b. Gradation in accordance with ASTM D6913 and ASTM D7928. Perform one test for every 100 cubic yards of each material to be incorporated into the Work.

c. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials to be incorporated into the Work: suitable soil material, and soil structural fill.

d. Moisture/density relations for fill in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 1,000 cubic yards of each material to be incorporated into the Work.

e. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of each material to be incorporated into the Work.

f. Strength in accordance with ASTM D2166. Perform one test for every 1,000 cubic yards of the following types of materials to be incorporated into the Work: suitable soil material, and soil structural fill.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
    a. Schedule (table or written narrative) indicating, for each specific area of the Work, type of fill materials proposed, together with indication of whether source of materials is onsite or borrow source. Identification of each type of material shall employ material names/designations identical to those in the Contract Documents.
2. Product Data:
    a. Borrow Soil Materials: Name and address of Supplier of borrow soil materials, gradation, and Supplier's certification that materials are sufficiently free of Constituents of Concern so that a Hazardous Environmental Condition will not be created or exacerbated. If no soil materials will be obtained from any borrow location, expressly so indicate to Engineer in writing.
    b. Aggregate: Supplier's published description of aggregate materials, including name and address of Supplier, certification of material's compliance with AASHTO and state department of transportation standards, and gradation.

B. Informational Submittals: Submit the following:
1. Procedure Submittals:
    a. Excavation plan indicating:
        1) Excavation Method(s): Indicate high-level methods to be used for excavating, such as use of backhoe or other earth moving construction equipment, use of explosives in excavating (when allowed), trenchless excavating methods, micro-trenching, hydro-excavating (when allowed), air vacuum excavating (when allowed), or other. Where different methods will be used, indicate locations of each in the Work. Purpose of indicating high-level excavating methods is for Owner's information regarding effect of excavating method on Owner's or facility manager's (if other than Owner) property and operations.
        2) Copies of permits and approvals required for excavation and fill Work, obtained from authorities having jurisdiction, including owners of affected utilities and transportation facilities, for excavation methods proposed.
    b. Compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
    c. Engineer's acceptance of excavation plan does not, in any way, modify Contractor's sole responsibility for complying with the Contract Documents, construction means, methods, procedures, techniques, or sequences, and safety and protection measures incident thereto.
2. Quality Assurance Test Results Submittals:
    a. Submit results of quality assurance testing performed in accordance with this Section's "Quality Assurance" Article, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
        1) Tests on materials from onsite and borrow sources.
        2) Optimum moisture – maximum dry density curve for each type of fill material.
3. Field Quality Control Submittals:
    a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
        1) Indication of soil classification in accordance with ASTM D2487.
        2) Field density testing.
        3) Proctor Compaction Test to determine optimum moisture for soil and maximum dry density.
4. Qualifications Statements:
    a. Quality assurance testing laboratory, when requested by Engineer.

1.6 FIELD CONDITIONS

A. Existing Conditions:

1. Subsurface Conditions:
   a. Subsurface Information: The Supplementary Conditions indicate information (if any) that is Technical Data on subsurface conditions at the Site. Such information and data are not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by Contractor. Owner and Engineer are not responsible for interpretations or conclusions drawn therefrom by Contractor.
   b. Contractor's Explorations: Soil borings and other exploratory operations may be made by Contractor, at no additional cost to Owner. Coordinate Contractor-performed test borings and other exploratory operations with Owner, utility owners, and owners of transportation facilities as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of Owner and others.
   c. Due to the presence of collapsible loess soils, extra care should be taken to divert surface water away from structures and equipment pads. Infiltration facilities, if planned, should be located away from structures and in coordination with the project geotechnical engineer.
   d. Groundwater was not encountered in our explorations. Based on nearby, historic well logs it is anticipated groundwater is over 20 feet below existing site grades.
2. Where subsurface conditions or locations of Underground Facilities and structures are unforeseen or differ substantively from that shown or indicated in the Contract Documents, comply with Contract requirements for giving notice and other actions.
3. Existing Structures and Underground Facilities:
   a. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. Contractor shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by Contractor. Immediately repair and restore existing structures and Underground Facilities damaged by Contractor without additional cost to Owner.
   b. Movement or operation of construction equipment and machinery over Underground Facilities shall be at Contractor's sole risk. When required by owner of the Underground Facility, prepare and submit to owner of such Underground Facility, and obtain their acceptance, of Contractor's plan presenting Contractor's analysis of the loads to be imparted during construction (including transient loading by construction equipment, machinery, and vehicles) and Contractor's proposed measures to protect structures and Underground Facilities during the Work.
   c. Acceptance of or approval by utility owner or Engineer of Contractor's proposed evaluation and method(s) for protecting Underground Facilities in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, means, methods, procedures, techniques, and sequences of construction, and the safety and protection measures incident thereto.
   d. Coordinate with utility owners for shut off of services in active piping and conduits. When required by utility owner, Owner will assist Contractor with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
   e. In general, service lines and laterals to individual residences, businesses, buildings, and structures, are not shown; however, Contractor shall assume that a service exists for each utility owner to each residence, business, building, structure, and property.
   f. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when such interruption is indicated in the Contract Documents or when

allowed in writing by Engineer after acceptable temporary utility services are provided by Contractor for the affected structure or property.

PART 2 -PRODUCTS

2.1 MATERIALS

A. Granular Structural Fill:

Granular structural fill, sometimes called “select granular fill”, is required for improving subgrade (after removal of unsuitable material), as backfill for excavations in areas that, after restoration, will be subject to vehicular traffic, and at other locations shown or indicated for such material in the Contract Documents. The native soil contains a high percentage of fines and will be sensitive to changes in moisture content. Therefore, imported structural fill meeting the requirements described above should be used where structural fill is necessary. Site soils that cannot be reused as structural fill should be disposed of at a suitable off-site location, or in landscaped areas where several inches of post-construction settlement is acceptable.

1. MATERIALS
   a. Materials used to construct the building pad, placed under foundations and hardscape, and used to backfill utility trenches are classified as structural fill. Quality of structural fill material varies depending upon its use as described below:
      1) Structural fill placed below new buildings should consist of crushed aggregate granular structural fill, with a maximum particle size of 2 inches, as described in Section 802.2.2 of the 2020 ISPWC.
      2) To provide uniform support, utility line bedding material should meet the requirements of Pipe Bedding, as described in Section 305 of the 2020 ISPWC.
      3) Utility trench backfill should consist of crushed aggregate granular structural fill, with a maximum particle size of 2 inches, as described in Section 802.2.2 of the 2020 ISPWC.
      4)
      5) Structural fill placed as capillary break below slabs should consist of Type 1 Crushed Aggregate ¾ inch minus in accordance with Section 802 of the 2020 ISPWC.
      6) Aggregate Surfacing placed as the running surface of the aggregate-surfaced road should conform to Type 1 Crushed Aggregate ¾ inch minus crushed aggregate in accordance with Section 802.2 of the 2020 ISPWC.
      7) Geosynthetics placed for subgrade stabilization should consist of Type II Subgrade Separation Geotextile that conforms to the requirements of Section 2050, Part 2.3 of the 2020 ISPWC.
      8) Geosynthetics placed to prevent the migration of fines (i.e. around footing drains) should consist of drainage geotextile that conforms to the requirements of Section 2050, Part 2.1 of the 2020 ISPWC.

B. Suitable Soil Material as Non-Structural Fill:

1. Provide suitable soil material as fill for the Work, unless other material is required.
2. Material shall be:
   a. Free of rock larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious material.
   b. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
   c. Liquid limit: Not greater than 45.
   d. Plasticity index: not greater than 20.
3. Previously-excavated materials complying with the Contract Documents requirements for suitable soil material may be used for suitable soil material.

4. When onsite materials are unsuitable for use as suitable soil material, provide granular structural fill or approved borrow material as suitable soil material. Prior to using borrow material as suitable soil material, furnish product data Submittal and quality assurance Submittal for proposed material and obtain Engineer's approval and acceptance (as applicable) of the proposed material.

C. Subbase Material:

1. Subbase material is granular material underlying pavement, sidewalks, and other surfaces expressly indicated in the Contract Documents.
2. Subbase course placed for the aggregate-surface road should consist of 1-inch Uncrushed Aggregate in accordance with Table 1 of Section 801.2.2 of the 2020 ISPWC, with the percent passing the No. 200 limited to 10 percent.

D. Flowable Fill, also known as Controlled Low Strength Material (CLSM):

1. Coordinate the provision below with requirements for installing flowable fill in this Section's "Filling and Compacting" Article in "Part 3 – Execution". Unless expressly required otherwise by the Contract Documents, flowable fill may be used, at Contractor's option (following Engineer's approval), for backfilling in lieu of the following materials: granular structural fill, pipe bedding material, soil structural fill, suitable soil material used as non-structural fill, and subbase material.
2. Comply with Section 03 31 30 - Concrete Materials and Proportioning.
3. Material provided shall be excavatable by ordinary mechanical excavation equipment, such as backhoes.

E. Drainage Fill:

1. Drainage fill is material used for improving groundwater drainage. Drainage fill is not intended to support buildings, structures, or pavement, nor is drainage fill intended as pipe bedding material for permanent Underground Facilities.
2. Fill placed around perimeter footing drains, under slab drains, and cast-in-place wall drains should consist of Drain Rock in accordance with Table 1 of Section 801.2.2 of the 2020 ISPWC, but with the nominal maximum aggregate size limited to 1 inch.

F. Erosion Control Stone Fill (Rip-Rap):

1. Erosion control stone fill is stone material of required gradation provided at locations shown or indicated on the Drawings to dissipate energy of storm water runoff and storm water conveyed through culverts and piping, and to reduce the potential for erosion and scouring.
2. Erosion control stone fill material shall be blasted or broken un-weathered 6 to 8-inch diameter rock or recycled material acceptable to Engineer and entity responsible for the third-party reference specifications indicated in this provision. Slag is unacceptable.

2.2 SOURCE QUALITY CONTROL

A. Tests and Inspections at Source of Supply:

1. Perform quality assurance testing, and submit results to Engineer, in accordance with the "Quality Assurance" Article in Part 1 of this Section.

PART 3 -EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Provide Engineer with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. Engineer will advise Contractor in writing when Engineer is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

2. This Article, however, in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, for construction means, methods, procedures, techniques, and sequences, and for the safety and protection measures incident thereto.
3. Nothing in this Article, including action by Engineer or Resident Project Representative (if any), is for benefit of Contractor.

B. Installing the Work constitutes Contractor's approval of underlying work, subgrades, and field conditions prevailing at the time of the Work.

C. Due to the presence of collapsible loess soils, the Contractor shall take precautions to protect and prevent open trenches from experiencing water intrusion when located adjacent to existing pumping plant and proposed electrical building structures and slabs.

3.2 TEST PITS

A. Test Pits - General:

1. Test Pit Locations Not Shown or Indicated in the Contract Documents and Test Pits Not Part of a Dedicated Bid/Pay Item:
   a. In advance of other construction, excavate test pits, make observations and measurements, and promptly fill test pits.
   b. Purpose of test pits is to determine existing subsurface conditions and locations of Underground Facilities and structures.
   c. Perform all work required in connection with excavating, stockpiling, maintaining, temporarily supporting excavations, filling, and replacing pavement for test pits. Contractor is responsible for the definite location of each existing Underground Facilities involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting affected Underground Facility or structure. Contractor is responsible for repairing, at Contractor's cost, damage to Underground Facility or structure caused during the Work.

B. Payment for Test Pits:

1. None.

C. Results of Test Pits:

1. Document results of all test pits excavated by Contractor.
2. Submit to Engineer written results of test pits expressly required by the Contract Documents or directed by Engineer. Furnish such Submittal within three days of excavation of associated test pit unless Engineer allows more time. When Engineer requests written results of test pits performed for Contractor's own use, promptly furnish such information as Informational Submittal.
3. Required documentation of test pits shall include:
   a. Identification of Project, Site, and Contractor.
   b. Date and time of test pit excavation, indication of weather conditions, and names of personnel present and employer of each.
   c. Detailed description of location of test pit, including, where necessary, measurements to landmarks shown on the Drawings. Where appropriate, include sketch of location from the Drawings.
   d. Indication of approximate dimensions of test pit, including length, width, and depth.
   e. Verbal (written) description of observed subsurface conditions, including apparent strata, rock (if any), groundwater conditions, and approximate depth at which each was observed.
   f. Verbal (written) description of unusual conditions observed, including potential existence of Hazardous Environmental Condition, if any. Include pertinent data, such as readings from instrumentation used.

g. Description and sketch, with appropriate dimensions, of Underground Facilities and structures in the test pit. Sketches shall be clearly legible with clear, well-written annotations and dimensions.

h. Other pertinent information and data from observations made while test pit was open.

i. Brief written description of backfilling and restoration of test pit, including time operations were completed.

3.3 PREPARATION

A. Site Preparation:

1. Comply with Section 31 10 00 - Site Clearing and Section 01 57 05 – Temporary Controls
2. Comply with this Section's "Erosion and Sediment Control During Construction" Article.

B. Dust Control:

1. Relative to controlling dust during construction, comply with Section 01 57 05 - Temporary Controls and Section 01 74 00 - Cleaning.

C. Maintenance and Protection of Traffic:

1. Give reasonable notice to owners or tenants of private property who may be affected by construction operations. Give such notice not less than 10 days prior to construction that will affect the property.
2. All hydrants, valves, fire alarm boxes, mailboxes, express courier drop boxes, and other facilities that may require access during construction shall be kept accessible for use.
3. Provide temporary signage, signals, barricades, warning lights, lighting and other equipment, service, and personnel necessary and required to regulate and protect traffic and warn of hazards. Such Work shall comply with requirements of owner of right-of-way and authorities having jurisdiction at the Site. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified conditions, as applicable.

3.4 EROSION AND SEDIMENT CONTROLS DURING CONSTRUCTION

A. Temporary Erosion and Sediment Controls - General:

1. Provide temporary erosion and sediment controls in accordance with Section 01 57 05 - Temporary Controls, and other requirements of the Contract Documents.
2. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction and the Project's storm water pollution prevention plan and permit, if any.

3.5 EXCAVATION

A. Excavation - General:

1. Perform all excavation required to complete the Work as shown, specified, and required. Excavating Work includes removing, handling, and proper disposal of earth, sand, clay, expansive-type soils, other unsuitable soil materials, gravel, hardpan, soft, weathered or decomposed rock, concrete and masonry (reinforced or unreinforced), pavements, rubbish, debris, stumps, and other materials, regardless of moisture content, within the excavation limits.
2. Excavation and filling Work shall comply with the Contract Documents, including required contours, elevations, general dimensions, and alignment shown or indicated on the Drawings including cuts, fills, and embankments, as applicable.
3. Protect existing buildings and structures against undermining and destabilization. If excavations affect adjacent foundations, advise Engineer in writing.
4. If unsuitable material and obstructions are encountered during excavation, remove material and replace as directed by Engineer.

B. Excavation Methods:

1. Traditional Excavation Methods: Excavation via traditional methods, such as backhoe, bulldozer, other earth moving construction equipment or machinery, or excavation using hand tools, is acceptable for all excavating Work.
2. Use of Explosives:
   a. Use of explosives is not allowed.
3. Micro-trenching: Installation of buried utilities using micro-trenching equipment and techniques is acceptable when the associated Underground Facility is of a size and depth appropriate for such construction method. Submit to Engineer request for interpretation or clarification for requirements for resin backfilling of micro-trenches. Engineer will issue such requirements via Field Order.
4. Trenchless: Where Contractor proposes trenchless construction techniques, such as directional drilling, micro-tunneling, or others, comply with the Contract Documents regarding such construction methods. When the Contract Documents do not include requirements for the proposed trenchless construction method, submit to Engineer request for interpretation or clarification to obtain appropriate requirements, which will be issued via appropriate Contract modification.

C. Excavation Protection:

1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
2. Provide safe access to excavations, including emergency exit, and safe access for construction equipment and machinery, where applicable, in accordance with laws and Regulations.

D. Excavations for Buildings, Structures, and Footings:

1. Elevation of bottom of footings shown is approximate. Engineer may direct, via appropriate Contract modifications, such minor changes in dimensions and elevations as may be required to ensure a stable bearing surface.
2. Extend excavations sufficiently on each side of structures, footings, and similar construction for installing forms, temporary supports of excavations, observation and inspection of the Work, and safe sloping of sides of excavations, as necessary.

E. Subgrades - General:

1. Provide firm, dense, thoroughly compacted, consolidated subgrades, free of mud, muck, and other soft and unsuitable materials. Subgrades shall remain firm and intact under all construction operations. Reinforce subgrade by providing granular structural fill on subgrades that are otherwise solid but become soft or muddy on top due to construction operations. Finished elevation of stabilized subgrades shall not be above subgrade elevations
2. If, in Engineer's opinion, subgrade becomes soft, muddy, or both, because of construction delays, failure to dewater properly, or other cause within Contractor's control, excavate subgrade to firm material, trim the subgrade, and backfill with granular structural fill material at Contractor's cost.
3. Remove unsuitable subgrade materials below foundations. Limits of required removal of unsuitable material, when not otherwise expressly shown or indicated in the Contract Documents, shall be outside exterior limits of foundations around perimeter of building or structure by not less than the greater of the following horizontal distances:
   a. Distance equal to depth of required removal of unsuitable material, below bottom of foundations.
   b. Three feet.
   c. As directed by Engineer, in consultation with geotechnical engineering special inspector or consultant (if any).

4. Preparation of Subgrades for Subsequent Work:
    a. Level off subgrades to receive foundations or compacted fill.
    b. Where subgrades are to receive subsequent fill or construction of buildings or structures, remove loose materials and bring subgrades into compliance with the Contract Documents.
    c. Where compacted fill material is required to bring subgrade up to underside of construction, scarify existing subgrade upon which fill material will be placed to depth of six inches and then compact to density required in this Section before fill material is placed thereon.
    d. Do not excavate lower than required for foundations and specified underlay, unless directed otherwise by Engineer.
    e. Where excavation extends below required elevation without authorization, promptly advise Engineer and remedy unauthorized excavation in accordance with the Contract Documents. Corrections may include:
        1) Under soil-supported foundations or soil-supported retaining walls:
            a) Fill unauthorized excavation by extending shown or indicated bottom elevation of foundation to excavation bottom, without altering required top elevation.
            b) Concrete fill, compacted structural fill, or CLSM are acceptable for bringing elevations to proper position.
        2) For locations other than those indicated above including slabs-on-grade and pile-supported foundations:
            a) Backfill and compact unauthorized excavations as indicated for authorized excavations of same classification, unless otherwise directed by Engineer.
        3) Contractor is not eligible for change in Contract Price or Contract Times for remedying unauthorized excavations.
5. Evaluation and Protection of Subgrade:
    a. Advise Engineer as soon as excavation is completed for Engineer's observation of subgrades and, where necessary or required, inspection and testing of subgrades by special inspectors.
    b. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide subgrade stabilization as indicated in this Article.
    c. Do not commence further construction until subgrade under compacted fill material, under foundations and retaining walls is acceptable (in accordance with the Contract Documents) to Engineer, who may consider results of required testing and special inspections (if any), and who may elect to consult with geotechnical special inspector or other consultant (if any).
    d. Engineer shall have sufficient opportunity to observe subgrade, after successful completion of special inspections (if any), and other tests and inspections required by the Contract Documents.
    e. Place fill material and perform subsequent construction after subgrade is acceptable in accordance with the Contract Documents.
    f. Protect subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
6. Subgrade stabilization:
    a. If subgrade under foundations or fill material, is frozen, loose, wet, or soft before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Engineer, who may consult with geotechnical special inspector or other consultant.
    b. Loose, wet, or soft materials, when approved by Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
    c. Stabilization shall be in accordance with the Contract Documents. Where the Contract Documents do not address subgrade stabilization, promptly submit to Engineer written

request for clarification or interpretation, or other written instrument in accordance with the Contract Documents. In such event, do not proceed until response is obtained from engineer.

F. Pipe Trench Preparation:

1. See Section 31 23 33 – Utilities – Trenching and Backfilling.

G. Preparation for Slabs-on-Grade and Equipment Support Pads:

1. Do not place floor slabs-on-grade including equipment support pads until all the following conditions are met:
   a. Subgrade is acceptable in accordance with the Contract Documents.
   b. Required fill material (where applicable) has been provided on subgrade in accordance with the Contract Documents.
   c. Underground Facilities are installed and have successfully completed required field testing and inspections.
   d. Contractor obtains Engineer's acceptance of required field quality control Submittals for subgrade and under-slab materials required by the Contract.

H. Freeze Protection:

1. Do not place foundations or fill material on frozen subgrade.
2. When freezing temperatures are expected, based on widely-recognized, reputable source for weather forecasts at or near the Site, do not excavate to full depth indicated, unless foundations or fill material can be placed immediately after excavation has been completed and is acceptable in accordance with the Contract Documents.
3. Protect from freezing excavation, subgrade, and fill materials when subsequent Work thereon is delayed.
4. Where concrete slab is a base slab-on-grade under and within building or structure that will not be heated, protect subgrade under slab from freezing until Substantial Completion.
5. Protect subgrade under foundations (supporting building or structure that will include environmental controls such as heating0 or air conditioning) from freezing until associated building structure is completed and heated to not less than 50 degrees F.

3.6 FILLING AND COMPACTING

A. Filling and Compacting - General:

1. Provide and compact all fill required for the finished grades as shown and as indicated in this Section.

B. Place fill as promptly as progress of the Work allows, but not until completing the following:

1. Obtaining Engineer's concurrence, after observation by Engineer or Resident Project Representative (if any) of construction below finish grade, including removal of formwork, removal of trash and debris from excavations, dampproofing, waterproofing, perimeter insulation, concrete finishing and related Work.
2. Successful completion of required field quality control activities for Work that will be covered or concealed by filling, including field quality control testing of buried piping, conduits that will convey fluid or gas, structures that will contain fluid or gas, and exfiltration testing (where performed or required) of manholes, chambers, vaults, and similar items. For manholes, chambers, and vaults, where infiltration testing or vacuum testing is performed or required, such testing may be performed following backfilling. Completion of proper documentation of as-constructed conditions and existing conditions (such as locations of Underground Facilities) in accordance with Section 01 78 39 - Project Record Documents.
3. Removal of temporary supports of excavations and, where applicable, filling voids in concrete where such voids resulted from temporary support of excavations.
4. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.

5. Remove fill that includes organic materials or other unacceptable material and replace with fill material complying with the Contract Documents.

C. Placement - General:

1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around buildings, structures, individual walls, piers, or columns, and Underground Facilities.
2. Management of Moisture Content:
   a. Place fill materials at moisture content and density as indicated in this Article's requirements on compaction density. Prior to placing fill material, optimum moisture and maximum density properties for proposed material shall be obtained from Engineer, who may consult with geotechnical special inspector, if any, or geotechnical consultant, if any. Furnish and use construction equipment and machinery capable of adding measured amounts of water to fill materials to bring fill materials to a condition within required moisture content range. Control moisture for each lift necessary for required compaction.
   b. Furnish and use construction equipment and machinery capable of discing, aerating, and mixing fill materials to ensure reasonable uniformity of moisture content throughout fill materials, and to reduce moisture content of borrow materials by air drying, when necessary.
   c. When subgrade or fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted.
   d. Materials at moisture content in excess of specified limit shall be dried by appropriate means, such as aeration or stockpiling for gravity drainage and air drying.
3. Compaction:
   a. Compaction Equipment:
      1) Perform compaction with construction equipment and machinery suitable for the type of fill material placed. Unless otherwise required, compact cohesive soils using sheepsfoot compactor, and compact granular materials using pneumatic rollers, vibrators, or other construction equipment or machinery to obtain required density.
      2) Select and use equipment capable of providing the minimum density required in the Contract Documents.
      3) Use light compaction equipment and machinery, with equipment or machinery gross weight not exceeding 7,000 pounds within horizontal distance of 10 feet from the wall of completed, below-grade structures.
      4) Furnish and use construction equipment and machinery capable of compacting in restricted areas next to structures and around piping and Underground Facilities.
   b. Compaction Test Area:
      1) Effectiveness of construction equipment and machinery selected by Contractor for compacting, shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed.
      2) If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the quantity of coverages, decrease the lift thicknesses, or use different compactor equipment or machinery.
4. Placement of Lifts and Compaction:
   a. Place fill materials in horizontal, loose lifts, not exceeding specified thickness prior to compacting.
   b. Place fill in manner ensuring uniform lift thickness after placing.
   c. Preparation of surfaces for placement of fill:
      1) Before commencing placing of fill, scarify underlying material to depth of six inches.
      2) Where ground surface is steeper than one vertical to four horizontal ("1V:4H"), plow surface to bench and break up surface so that fill material will bind with existing surface. For slopes steeper than 1V:4H and less than 1V:1.5H, bench shall be six

feet wide. For slopes steeper than or equal to 1V:1.5H and less than 1V:0.5H, bench shall be four feet wide.

d. Mechanically compact each lift, by not less than two complete coverages of compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface.

e. Compaction of fill materials by inundation with water is unacceptable.

5. Restrictions:

a. Do not place fill materials when standing water is present on surface of area where fill will be placed.

b. Do not compact fill when standing water is present on the fill to be compacted.

c. Do not place or compact fill in frozen condition or on top of frozen material.

d. Fill containing organic or deleterious materials or other unacceptable material previously described shall be removed and replaced prior to compaction.

6. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment or machinery, perform all work necessary to provide required densities. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.

7. Repair, at Contractor's cost, observed or measured settlement. Make repairs and replacements as necessary and required within 30 days after being so advised by Engineer, unless more-timely action is necessary to avoid or reduce the potential for safety hazards or damage to property.

D. Fill Against Concrete:

1. Structures shall be complete prior to backfilling, including foundations, walls, and slabs, including top slabs, unless shown or indicated otherwise in the Contract Documents.

2. Placing fill against concrete below finished grade is not allowed until concrete has attained its specified full design compressive strength in accordance with Section 03 31 30 - Concrete Materials and Proportioning, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in the Specifications in Division 03 - Concrete.

3. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.

4. Backfill structural foundation elements as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.

5. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

E. Fill Placed in Electrical Ductbank Trenches:

1. Provide suitable soil material for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another Underground Facility, provide granular structural fill to the elevation of the bottom of upper ductbank or Underground Facility, as applicable.

F. Installation of Flowable Fill, also known as Controlled Low Strength Material (CLSM):

1. Discharge flowable fill from ready-mix delivery vehicle into excavation, or other space to be backfilled with such material, via chutes, pumping, or hand-carried in buckets, in accordance with the Contract Documents (including the Specifications of Division 03 - Concrete) and requirements of flowable fill ready-mix Supplier.

2. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.

3. Place flowable fill in lifts not greater than four feet depth.

4. Placing of each lift of flowable fill shall be a continuous operation, to the extent practicable.
5. Place flowable fill in manner that prevents flotation of piping or other damage to the Work, other Underground Facilities, and adjacent property.
6. Cold Weather Placing:
   a. Do not place flowable fill on frozen subgrade.
   b. Flowable fill batching, mixing, and placing may be performed when weather conditions are favorable, and ambient air temperature is 34 degrees F and rising.
   c. At the time of placing, flowable fill must have a temperature of not less than 40 degrees F.
   d. Discontinue placing flowable fill when ambient air temperature is 38 degrees F or less and falling.
7. After placing flowable fill, allow not less than 12 hours before placing subsequent lift or approved otherwise by Engineer.
8. Prevent contact with flowable fill by construction vehicles and equipment, or other traffic, for not less than 24 hours after placing, or until flowable fill is sufficiently hard to prevent rutting or other damage by vehicles and construction equipment.

G. Compaction Density Requirements:

1. Compaction Requirements for Sitework (including civil, grading, and Underground Facilities):

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under Pavement, Other Traveled Ways, Curbs, Gutters, Sidewalks, and Buried Utilities:		
All soils	90% per ASTM D1557	-2 to +3% of optimum
Soils within 2 feet of final subgrade	95% per ASTM D1557	
Sitework Not Covered by the Above Category or Classification:		
Cohesive soils	90% of ASTM D1557	-2 to +3% of optimum
Cohesionless soils	90% of ASTM D1557	

2. Compaction Requirements for Materials Supporting Buildings and Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Inside buildings and structures, under foundations, under equipment support pads, under slabs-on-grade and mats, and scarified existing subgrade under fill material	95% of ASTM D1557	-2 to +3% of optimum
Outside buildings and structures adjacent to walls, piers, columns, and other structure exterior member	92% per ASTM D698	-2 to +3% of optimum

3. Compaction Density and Moisture Requirements for Specific Areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside buildings and structures, under slabs-on-grade	95% per ASTM D1557	-2 to +3% of optimum
Behind below-grade walls	90-92% per ASTM D1557	-2 to +3% of optimum

4. Fill Lift Thickness:

a. Unless expressly shown or indicated otherwise, place fill in trenches, below piping, below foundations, or under paved areas in horizontal loose lifts not exceeding 8 inches in thickness if using heavy compactors, or 4 inches if using hand-operated equipment, and thoroughly compact each before next layer is placed.

b. In pipe trenches, above elevation of bottom of pipe, horizontal uncompacted layers shall be six inches deep.

5. Fill Moisture Content: Fill shall be wetted and thoroughly mixed to achieve moisture content to within the required range indicated in the applicable table, above, with the following exception(s):

a. On-site clayey soils: Optimum to plus three percent (moisture less than optimum is unacceptable).

6. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated.

7. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is indicated in this Section's "Field Quality Control" Article.

8. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the required compaction. Perform additional compaction Work at no additional cost to Owner until required compaction is achieved. Such work includes complete removal of unacceptable (as determined by Engineer) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

H. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with granular structural fill material and thoroughly compact in accordance with applicable table in this provision. Slope the sides of excavation in accordance with the maximum allowable inclinations specified for each structure location.

3.7 UNAUTHORIZED EXCAVATION

A. Unauthorized Excavation – General:

1. Excavations outside lines and grades shown or indicated and that are not approved by Engineer (including excavations below required subgrade elevation, unless Engineer directs removal of unsuitable subgrade material), together with removing and disposing of the associated material, shall be at Contractor's cost and risk.

2. Fill unauthorized excavations with properly-compacted granular structural fill material at Contractor's cost.

3.8 PAVEMENT SUBBASE COURSE

A. Pavement Subbase - General:

1. Place subbase material, in layers of specified thickness, over subgrade to support pavement base course.

2. Prepare subgrade underlying subbase course in accordance with this Section's general requirements for subgrades.

B. Grade Control:

1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Placing of Pavement Subbase Course:

1. Provide subbase material where required to the limits shown or indicated.

2. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. If the Contract Documents do not show or indicate required section of replacement paving (if any), replacement subbase course shall be of thickness equal to existing subbase course.

3. Maintain optimum moisture content for compacting subbase material during placing operations.
4. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over compacted subbase.
5. To prevent softening of subgrade, do not install pavement subbase in excess of 500 feet in length without compacting.
6. If subgrade material becomes churned up into or mixed with subbase material, remove the mixed material and replace with clean, compacted subbase material.

3.9 GRADING

A. Grading - General:

1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines:

1. Grade areas adjacent to building lines to drain away from buildings and structures.
2. Grade to prevent ponding of water. Provide grades and slopes as shown on the Drawings and to allow effective drainage to proper drainage routes, such as catch basins, ditches or swales intended to convey storm water, and other storm water drainage routes. Where intended grade for effective drainage is unclear, promptly submit to Engineer request for interpretation and obtain Engineer's interpretation or clarification before proceeding,
3. Provide final surfaces free of irregular surface changes, in accordance with the following:
   a. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below required subgrade elevation.
   b. Pavement (including hard-surfaced pavement and areas with stone surfacing): Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 0.5-inch above or below required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs-on-Grade and Concrete Mats:

1. Grade smooth and even, free of voids, compacted as specified, and to required elevation.
2. Provide final grades within tolerance of 0.5-inch when tested with a ten foot straight edge.

3.10 DISPOSAL OF EXCAVATED SPOIL MATERIALS

A. Spoil Disposal - General:

1. Contractor shall haul away excavated material that does not comply with requirements for fill, or is in excess of quantity required for fill.
2. Disposal of materials shall comply with Laws and Regulations, at no additional cost to Owner.

3.11 FIELD QUALITY CONTROL

A. Site Tests and Inspections:

1. Testing Laboratory:
   a. Employ a testing laboratory to perform field quality control testing.
   b. Testing Laboratory Scope:
      1) Perform field moisture content tests (in accordance with ASTM D2216 or ASTM D6938) and density tests (in accordance with ASTM D1556 or ASTM D6938) to verify that required compaction of fill materials was provided.
      2) Tests of actual unconfined compressive strength or bearing tests (in accordance with ASTM D2850 or ASTM D2166) on each stratum.

3) Furnish to Engineer and Contractor written results of each test.

c. Authority and Duties of Testing Laboratory:

1) Testing laboratory representatives ("technician") shall inspect the materials in the field, perform testing, and report findings to Engineer and Contractor. When the Work is defective, technician will direct attention of Engineer and Contractor to such defective Work.

2) Technician will not supervise performance of any of Contractor's Work. Technician shall not perform other duties for Contractor.

3) Work will be tested and inspected by testing laboratory as the Work progresses, but failure to detect defective Work (including defective materials) shall not, in any way, prevent later rejection when defect is discovered, nor shall it obligate Engineer for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.

2. Geotechnical Special Inspector or Consultant:

a. Owner will employ a geotechnical special inspector or consultant to be onsite during critical portions of excavation and fill Work to provide Owner with greater assurance concerning subsurface conditions and quality of required excavation and fill Work. Owner's furnishing of services of geotechnical special inspector or consultant is not for Contractor's benefit. Owner and Engineer have the right to rely on accuracy and completeness of reports and observations of geotechnical special inspector or consultant.

3. Responsibilities and Duties of Contractor:

a. Use of testing laboratory or geotechnical special inspector or consultant in no way relieves Contractor of responsibility to provide Work in compliance with the Contract Documents.

b. When Owner furnishes services of testing laboratory, special inspector, consultant, or any combination thereof, for excavation and fill Work, Owner and Engineer do not represent that the sampling and testing performed by Owner-hired testing laboratory or inspections by Owner-hired special inspectors or consultants, is sufficient for Contractor's purposes, or to monitor all aspects of the excavation and fill Work. If additional quality control is needed to verify that the Work performed and materials delivered to the Site are in accordance with the Contract Documents, Contractor may retain its own, independent testing laboratory to perform additional sampling and testing for Contractor's purposes.

c. To facilitate testing laboratory, special inspectors, and consultants, Contractor shall advise testing laboratory, special inspectors, and consultants not less than two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.

d. Contractor shall be responsible for providing required compaction for fill and other earthwork. Contractor shall control construction operations by performing confirming tests to verify that Contractor has complied with the Contract Documents relative to compaction and moisture content.

e. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.

1) 200 linear feet of trench fill.

2) 10 cubic yards of granular structural fill.

3) 100 cubic yards of suitable soil material.

4) 50 cubic yards of subbase material.

4. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be as follows:

a. Trenches for Structures, and Underground Facilities (including buried ductbanks):
   1) In Open Fields: Two locations every 1,000 linear feet.
   2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
   3) Crossing Paved Roads: Two locations along each crossing.
   4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to Engineer.
c. For granular structural fill: Once per lift for each 1,000 square feet placed and compacted.
d. For Suitable Soil Material: One per 1,000 square feet on every compacted lift.
e. Subbase Material: One per 1,000 square feet on every compacted lift.

5. Periodic compliance tests will be made by Engineer to verify that compaction is in accordance with the Contract Documents, at no cost to Contractor. Contractor shall remove overburden above the level at which Engineer wishes to test and shall fill and re-compact the material after testing is complete.

B. Defective Work:

1. If testing laboratory reports or inspections indicate subgrade, fill, or bedding compaction less than specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's cost until subgrades, bedding, and fill are acceptable.
2. Costs for retesting of subgrade, fill, or bedding materials that did not originally comply with the Contract Documents, including required density, shall be paid by Contractor.

3.12 RESTORATION

A. Restoration - General:

1. Perform finish grading, including providing topsoil, in accordance with Section 31 22 19 - Finish Grading.
2. Provide replacement paving, sidewalks, curbs, gutters, and similar items in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.
3. Restore landscaping including lawn and meadow areas, in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.

END OF SECTION

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SECTION 31 23 33
UTILITIES - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for excavating, filling, and other earth Work for linear, buried utility projects, including:
   a. Field conditions.
   b. Soil and aggregate materials.
   c. Test pits.
   d. Excavation.
   e. Preparation of subgrades.
   f. Filling and compacting.
   g. Rough grading.
   h. Disposal of excavated spoil materials.

B. Related Requirements Include, but are not necessarily limited to, the following:

1. Section 31 10 00 - Site Clearing.
2. Section 31 22 19 - Finish Grading.
3. Geotechnical Engineering Report prepared by Ciani & Hatch Engineering, dated April 21, 2025.
4. Section 31 23 05 – Excavation and Fill

1.2 REFERENCES

A. Terminology:

1. See Geotechnical Engineering Report

B. Reference Standards: See Geotechnical Engineering Report for Additional Reference Standards. Standards referenced in this section include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. AMRL R18 - AASHTO Accreditation Procedure Manual.
2. ASTM International (ASTM):
   a. C33/C33M - Standard Specification for Concrete Aggregates.
   b. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
   c. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
   d. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   e. D2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.
   f. D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   g. D2434 - Standard Test Methods for Measurement of Hydraulic Conductivity of Coarse-Grained Soils.
   h. D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

i. D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.

j. D3740 - Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

k. D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

l. D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

m. D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

n. D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

o. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

p. D7928 - Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.

q. E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Contractor's Testing Laboratory:

a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of materials specified in this Section.

b. When Contractor is expressly required, by this Section's "Field Quality Control" Article or elsewhere in the Contract Documents, to retain testing laboratory for tests required under this Section's "Field Quality Control" Article, retain one testing laboratory for quality assurance testing and field quality control testing.

c. Testing laboratory shall possess current, valid accreditation from the AASHTO Materials Reference Laboratory (AMRL), in accordance with AASHTO AMRL R18, for ASTM D3740, for tests required for quality assurance testing indicated in this Article and field quality control testing indicated to be Contractor's responsibility.

d. Testing laboratory shall comply with ASTM E329.

e. Testing laboratory shall be experienced in the types of testing required.

f. Selection of testing laboratory is subject to Engineer's acceptance. Upon Engineer's request, submit qualifications statement for testing laboratory, including name of entity, location, copies of applicable certifications, summary of entity's experience, and names and qualifications of personnel who will perform the subject sampling and testing.

B. Quality Assurance Testing:

1. Quality assurance testing, which may also be regarded as source quality control testing, is in addition to field quality control testing required by this Section's "Field Quality Control" Article.

2. Materials used in the Work may require testing and retesting, as directed by Engineer, during the Project. Allow free access to onsite material stockpiles, borrow sources, and other sources of aggregate and soil materials at all times. Tests not specifically indicated to be performed at Owner's expense (if any), including retesting of defective materials and defective Work, shall be at Contractor's cost.

3. Contractor's Testing Laboratory Scope for Quality Assurance Sampling and Testing:

a. Obtain samples and perform testing of proposed fill materials in the laboratory, at the Site, and at borrow locations (if any) to provide assurance that the Work will comply with the Contract Documents.

b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.

c. Submit to Engineer, via Contractor, written results of each test.

4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:

a. Perform the following quality assurance tests on materials to be incorporated into the Work. Submit results of such tests to Engineer and obtain Engineer's acceptance thereof prior to incorporating the subject materials into the Work.

b. Gradation in accordance with ASTM D6913 and ASTM D7928. Perform one test for every 100 cubic yards of each material to be incorporated into the Work.

c. Atterberg limits in accordance with ASTM D4318. Perform one test for every 100 cubic yards of the following types of materials to be incorporated into the Work: suitable soil material, and soil structural fill.

d. Moisture/density relations for fill in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 100 cubic yards of each material to be incorporated into the Work.

e. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 100 cubic yards of each material to be incorporated into the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

a. Schedule (table or written narrative) indicating, for each specific area of the Work, type of fill materials proposed, together with indication of whether source of materials is onsite or borrow source. Identification of each type of material shall employ material names/designations identical to those in the Contract Documents.

2. Product Data:

a. Borrow Soil Materials: Name and address of Supplier of borrow soil materials, gradation, and Supplier's certification that materials are sufficiently free of Constituents of Concern so that a Hazardous Environmental Condition will not be created or exacerbated. If no soil materials will be obtained from any borrow location, expressly so indicate to Engineer in writing.

b. Aggregate: Supplier's published description of aggregate materials, including name and address of Supplier, certification of material's compliance with AASHTO and state department of transportation standards, and gradation.

B. Informational Submittals: Submit the following:

1. Procedure Submittals:

a. Excavation plan indicating:

1) Excavation Method(s): Indicate high-level methods to be used for excavating, such as use of backhoe or other earth moving construction equipment, use of explosives in excavating (when allowed), trenchless excavating methods, micro-trenching, hydro-excavating (when allowed), air vacuum excavating (when allowed), or other. Where different methods will be used, indicate locations of each in the Work. Purpose of indicating high-level excavating methods is for Owner's information regarding effect of excavating method on Owner's or facility manager's (if other than Owner) property and operations.

2) Copies of permits and approvals required for trenching, backfilling, and related earth Work, obtained from authorities having jurisdiction, including owners of affected utilities and transportation facilities, for excavation methods proposed.

b. Compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at

different locations at the Site, indicate where each procedure and equipment item will be used.

c. Engineer's acceptance of excavation plan does not, in any way, modify Contractor's sole responsibility for complying with the Contract Documents, construction means, methods, procedures, techniques, or sequences, and safety and protection measures incident thereto.

2. Quality Assurance Test Results Submittals:

a. Submit results of quality assurance testing performed in accordance with this Section's "Quality Assurance" Article, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:

1) Tests on materials from onsite and borrow sources.

2) Optimum moisture – maximum dry density curve for each type of fill material.

3. Field Quality Control Submittals:

a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:

1) Indication of soil classification in accordance with ASTM D2487.

2) Field density testing.

3) Proctor Compaction Test to determine optimum moisture for soil and maximum dry density.

4. Qualifications Statements:

a. Quality assurance testing laboratory, when requested by Engineer.

1.5 FIELD CONDITIONS

A. Existing Conditions:

Subsurface Conditions:

a. Subsurface Information: The Supplementary Conditions indicate information (if any) that is Technical Data on subsurface conditions at the Site. Such information and data are not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by Contractor. Owner and Engineer are not responsible for interpretations or conclusions drawn therefrom by Contractor.

b. Contractor's Explorations: Soil borings and other exploratory operations may be made by Contractor, at no additional cost to Owner. Coordinate Contractor-performed test borings and other exploratory operations with Owner, utility owners, and owners of transportation facilities as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of Owner and others.

c. Due to the presence of collapsible loess soils, extra care should be taken to divert surface water away from structures and equipment pads. Infiltration facilities, if planned, should be located away from structures and in coordination with the project geotechnical engineer.

d. Groundwater was not encountered in our explorations. Based on nearby, historic well logs it is anticipated groundwater is over 20 feet below existing site grades.

2. Where subsurface conditions or locations of Underground Facilities and structures are unforeseen or differ substantively from that shown or indicated in the Contract Documents, comply with Contract requirements for giving notice and other actions.

3. Existing Structures and Underground Facilities:

a. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. Contractor shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from

damage by Contractor. Immediately repair and restore existing structures and Underground Facilities damaged by Contractor without additional cost to Owner.

b. Movement or operation of construction equipment and machinery over Underground Facilities shall be at Contractor's sole risk. When required by owner of the Underground Facility, prepare and submit to owner of such Underground Facility, and obtain their acceptance, of Contractor's plan presenting Contractor's analysis of the loads to be imparted during construction (including transient loading by construction equipment, machinery, and vehicles) and Contractor's proposed measures to protect structures and Underground Facilities during the Work.

c. Acceptance of or approval by utility owner or Engineer of Contractor's proposed evaluation and method(s) for protecting Underground Facilities in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, means, methods, procedures, techniques, and sequences of construction, and the safety and protection measures incident thereto.

d. Coordinate with utility owners for shut off of services in active piping and conduits. When required by utility owner, Owner will assist Contractor with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.

e. In general, service lines and laterals to individual residences, businesses, buildings, and structures, are not shown; however, Contractor shall assume that a service exists for each utility owner to each residence, business, building, structure, and property.

f. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by Engineer after acceptable temporary utility services are provided by Contractor for the affected structure or property.

PART 2 - PRODUCTS

2.1 MATERIALS

1. Provide granular under-slab fill under foundations, manholes, chambers, vaults, handholes, and similar Work unless other under-slab material is required by the Contract Documents.
2. ASTM C33/C33M gradation size no. 67, or other material acceptable to Engineer.
3. Material shall be uniformly-graded, washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, free of organic and deleterious material, complying with the following:
   a. 100 percent passing a 1.5-inch sieve.
   b. Not more than five percent passing a no. 4 sieve.

B. Granular Structural Fill:

1. Granular structural fill, sometimes called "select granular fill", is required for improving subgrade (after removal of unsuitable material), as backfill for excavations in areas that, after restoration, will be subject to vehicular traffic, and at other locations shown or indicated for such material in the Contract Documents.

Materials used to construct the building pad, placed under foundations and hardscape, and used to backfill utility trenches are classified as structural fill for the purpose of this specification. Quality of structural fill material varies depending upon its use as described below:

- Structural fill placed below new buildings should consist of crushed aggregate granular structural fill, with a maximum particle size of 2 inches, as described in Section 802.2.2 of the 2020 ISPWC.
- To provide uniform support, utility line bedding material should meet the requirements of Pipe Bedding, as described in Section 305 of the 2020 ISPWC.
- Utility trench backfill should consist of crushed aggregate granular structural fill, with a maximum particle size of 2 inches, as described in Section 802.2.2 of the 2020 ISPWC.

- Structural fill placed around perimeter footing drains, under slab drains, and cast-in-place wall drains should consist of Drain Rock in accordance with Table 1 of Section 801.2.2 of the 2020 ISPWC, but with the nominal maximum aggregate size limited to 1 inch.
- Structural fill placed as capillary break below slabs should consist of Type 1 Crushed Aggregate ¾ inch minus in accordance with Section 802 of the 2020 ISPWC.
- Base course placed as the running surface of the aggregate-surfaced road should conform to Type 1 Crushed Aggregate ¾ inch minus crushed aggregate in accordance with Section 802.2 of the 2020 ISPWC.
- Subbase course placed for the aggregate-surface road should consist of 1-inch Uncrushed Aggregate in accordance with Table 1 of Section 801.2.2 of the 2020 ISPWC, with the percent passing the No. 200 limited to 10 percent.
- Geosynthetics placed for subgrade stabilization should consist of Type II Subgrade Separation Geotextile that conforms to the requirements of Section 2050, Part 2.3 of the 2020 ISPWC.
- Geosynthetics placed to prevent the migration of fines (i.e. around footing drains) should consist of drainage geotextile that conforms to the requirements of Section 2050, Part 2.1 of the 2020 ISPWC.

C. Suitable Soil Material as Non-Structural Fill:

1. Provide suitable soil material as fill for the Work, unless other material is required.
2. Material shall be:
   a. Free of rock larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious material.
   b. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
   c. Liquid limit: Not greater than 45.
   d. Plasticity index: not greater than 20.
3. Previously-excavated materials complying with the Contract Documents requirements for suitable soil material may be used for suitable soil material.
4. When onsite materials are unsuitable for use as suitable soil material, provide [granular structural fill] [soil structural fill] or approved borrow material as suitable soil material. Prior to using borrow material as suitable soil material, furnish product data Submittal and quality assurance Submittal for proposed material and obtain Engineer's approval and acceptance (as applicable) of the proposed material.

D. Subbase Material:

1. Subbase material is granular material underlying pavement, sidewalks, and other surfaces expressly indicated in the Contract Documents.
2. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Slag is unacceptable.
3. Material shall be Item703.11 of Idaho Transportation Department Standard Specifications.

E. Pipe Bedding Material:

1. Materials: Unless otherwise expressly required in the Contract Documents, pipe bedding material shall be crushed stone and gravel, free of: rock or gravel larger than one-inch in any dimension, debris, waste, frozen materials, organic material and other deleterious matter.
   a. Pipe bedding material shall be crushed stone and gravel, free of rock or gravel larger than 0.5-inch in any dimension.
2. Sand:
   a. Where expressly required or allowed by the Contract Documents, provide sand as pipe bedding material.

b. Sand material, where used, shall consist of natural or manufactured granular material and shall contain no organic material.

c. Sand shall be non-plastic, when tested in accordance with ASTM D4318.

d. Gradation: 100 percent shall pass a no. 4 sieve and not more than five percent shall pass a No. 200 sieve.

F. Flowable Fill, also known as Controlled Low Strength Material (CLSM):

1. Unless expressly required otherwise by the Contract Documents, flowable fill may be used, at Contractor's option (following Engineer's approval), for backfilling in lieu of the following materials:, pipe bedding material, soil structural fill, suitable soil material used as non-structural fill.
2. Comply with Section 03 31 - Concrete Materials and Proportioning.
3. Material provided shall be excavatable by ordinary mechanical excavation equipment, such as backhoes.

2.2 SOURCE QUALITY CONTROL

A. Tests and Inspections at Source of Supply:

1. Perform quality assurance testing, and submit results to Engineer, in accordance with the "Quality Assurance" Article in Part 1 of this Section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Provide Engineer with sufficient notice and with means to examine areas and conditions under which trenching, backfilling, other related earth Work, and grading will be performed. Engineer will advise Contractor in writing when Engineer is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
2. This Article, however, in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, for construction means, methods, procedures, techniques, and sequences, and for the safety and protection measures incident thereto.
3. Nothing in this Article, including action by Engineer or Resident Project Representative (if any), is for benefit of Contractor.

B. Installing the Work constitutes Contractor's approval of underlying work, subgrades, and field conditions prevailing at the time of the Work.

C. Due to the presence of collapsible loess soils, the Contractor shall take precautions to protect and prevent open trenches from experiencing water intrusion when located adjacent to existing pumping plant and proposed electrical building structures and slabs.

3.2 TEST PITS

A. Test Pits – See Section 31 23 05 – Excavation and Fill

a.

3.3 PREPARATION

A. Site Preparation:

1. Comply with Section 31 10 00 - Site Clearing.
2. Comply with Section 01 54 05 – Temporary Controls

B. Dust Control:

1. Relative to controlling dust during construction, comply with Section 01 57 05 - Temporary Controls and Section 01 74 00 - Cleaning.

3.4 EROSION AND SEDIMENT CONTROLS DURING CONSTRUCTION

A. Temporary Erosion and Sediment Controls – General:

1. Provide temporary erosion and sediment controls in accordance with Section 01 57 05 - Temporary Controls, and other requirements of the Contract Documents.
2. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction and the Project's storm water pollution prevention plan and permit, if any.

3.5 EXCAVATION

A. Excavation – General:

1. Perform all excavation Work, including trenching and backfilling, required to complete the Work as shown, specified, and required. Excavating Work includes removing, handling, and proper disposal of earth, sand, clay, expansive-type soils, other unsuitable soil materials, gravel, hardpan, soft, weathered or decomposed rock, concrete and masonry (reinforced or unreinforced), pavements, rubbish, debris, stumps, and other materials, regardless of moisture content, within the excavation limits.
2. Trenching and backfilling Work shall comply with the Contract Documents, including required grades, elevations, general dimensions, and alignment shown or indicated on the Drawings including cuts and fills, as applicable.
3. Protect existing buildings and structures against undermining and destabilization. If adjacent trenching affects foundations of one or more buildings or structures, promptly advise Engineer in writing.
4. If unsuitable material and obstructions are encountered during excavation, remove material and replace as directed by Engineer.

B. Excavation Methods:

1. Traditional Excavation Methods: Excavation via traditional methods, such as backhoe, bulldozer, other earth moving construction equipment or machinery, or excavation using hand tools, is acceptable for all excavating Work.
2. Use of Explosives:
   a. Use of explosives is not allowed.
3. Micro-trenching: Installation of buried utilities using micro-trenching equipment and techniques is acceptable when the associated Underground Facility is of a size and depth appropriate for such construction method. Submit to Engineer request for interpretation or clarification for requirements for resin backfilling of micro-trenches. Engineer will issue such requirements via Field Order.
4. Trenchless: Where Contractor proposes trenchless construction techniques, such as directional drilling, micro-tunneling, or others, comply with the Contract Documents regarding such construction methods. When the Contract Documents do not include requirements for the proposed trenchless construction method, submit to Engineer request for interpretation or clarification to obtain appropriate requirements, which will be issued via appropriate Contract modification.
5. Hydro-excavating (also known as Hydro-Vacuum Excavating):
   a. Hydro-excavating is unacceptable.
   b. Avoid creating nuisances, unsafe conditions, and inconvenience to Owner, facility manager, owners and occupants of adjacent property, and the public when hydro-excavating is allowed and used.
6. Air Vacuum Excavating:
   a. Air vacuum excavating is acceptable for all excavating Work.
   b. Avoid creating sandblasting outside of excavations, dust emissions, other nuisances, unsafe conditions, and inconvenience to Owner, facility manager, owners and occupants of adjacent property, and the public when air vacuum excavating is allowed and used.

C. Excavation Protection:

1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
2. Provide safe access to excavations, including emergency exit, and safe access for construction equipment and machinery, where applicable, in accordance with laws and Regulations.

D. Excavations for Manholes, Chambers, and Vaults:

1. Refer to this Section, Section 01 22 00 - Measurement and Payment, and applicable details (if any) on the Drawings for requirements on excavation pay limits for manholes, chambers, vaults, and similar items.
2. Elevation of bottom of manholes, chambers, and vaults may be changed only via duly issued Contract modification. Such modifications may be directed by Engineer to ensure a stable bearing surface. Elevations of piping, conduit, and similar other Underground Facilities shall be as shown or indicated on the Contract Documents.
3. Extend excavations sufficiently on each side of manholes, chambers, vaults, or similar construction only as necessary for installing precast concrete structures and appurtenances, including temporary supports of excavations, observation and inspection of the Work, and safe sloping of sides of excavations, as necessary.

E. Subgrades – General:

1. Provide firm, dense, thoroughly compacted, consolidated subgrades, free of mud, muck, and other soft and unsuitable materials. Subgrades shall remain firm and intact under all construction operations. Reinforce subgrade by providing granular structural fill on subgrades that are otherwise solid but become soft or muddy on top due to construction operations. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown on the Drawings,
2. If, in Engineer's opinion, subgrade becomes soft, muddy, or both, because of construction delays, failure to dewater properly, or other cause within Contractor's control, excavate subgrade to firm material, trim the subgrade, and backfill with granular structural fill material at Contractor's cost.
3. Remove unsuitable subgrade materials below foundations. Limits of required removal of unsuitable material, when not otherwise expressly shown or indicated in the Contract Documents, shall be outside exterior limits of foundations around perimeter of manhole, chamber, vault, or similar item, by not less than the greater of the following horizontal distances:
   a. Distance equal to depth of required removal of unsuitable material, below bottom of foundations.
   b. Three feet.
   c. As directed by Engineer, in consultation with geotechnical engineering consultant (if any).
4. Preparation of Subgrades for Subsequent Work:
   a. Level off subgrades to receive foundations or compacted fill.
   b. Where subgrades are to receive subsequent fill or manholes, chambers, vaults, or similar items, remove loose materials and bring subgrades into compliance with the Contract Documents.
   c. Where compacted fill material is required to bring subgrade up to underside of construction, scarify existing subgrade upon which fill material will be placed to depth of six inches and then compact to density required in this Section before fill material is placed thereon.
   d. Do not excavate lower than required for buried piping or foundations, unless directed otherwise by Engineer.

e. Where excavation extends below required elevation without authorization, promptly advise Engineer and remedy unauthorized excavation in accordance with the Contract Documents. Corrections may include:
   1) Under soil-supported foundations or soil-supported retaining walls:
      a) Filling entire vertical distance between excavated subgrade and material required under foundation or other structure with compacted [granular structural fill].
      b) Concrete fill is acceptable for bringing elevations to proper position.
   2) For locations other than those indicated above including slabs-on-grade:
      a) Backfill and compact unauthorized excavations as indicated for authorized excavations of same classification, unless otherwise directed by Engineer.
   3) Contractor is not eligible for change in Contract Price or Contract Times for remedying unauthorized excavations.

5. Evaluation and Protection of Subgrade:
   a. Advise Engineer as soon as excavation is completed for Engineer's observation of subgrades and, where necessary or required, inspection and testing of subgrades.
   b. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide subgrade stabilization as indicated in this Article.
   c. Do not commence further construction until subgrade under compacted fill material, under foundations and retaining walls is acceptable (in accordance with the Contract Documents) to Engineer, who may consider results of required testing, and who may elect to consult with geotechnical consultant (if any).
   d. Engineer shall have sufficient opportunity to observe subgrade, after successful completion of tests and inspections required by the Contract Documents.
   e. Place fill material and perform subsequent construction after subgrade is acceptable in accordance with the Contract Documents.
   f. Protect subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
6. Subgrade stabilization:
   a. If subgrade under foundations or fill material, is frozen, loose, wet, or soft before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Engineer, who may consult with geotechnical consultant.
   b. Loose, wet, or soft materials, when approved by Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
   c. Stabilization shall be in accordance with the Contract Documents. Where the Contract Documents do not address subgrade stabilization, promptly submit to Engineer written request for clarification or interpretation, or other written instrument in accordance with the Contract Documents. In such event, do not proceed until response is obtained from engineer.

F. Pipe Trench Preparation:
   1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
   2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
      a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. The Drawings show additional requirements for trenches. In no case shall trench be wider at top of pipe than pipe barrel's outside diameter (OD) plus two feet, unless otherwise shown or indicated.
      b. Enlargement of trench width at pipe joints may be made when required and approved by Engineer.

c. For excavating and backfilling for manholes, chambers, and vaults associated with buried piping, excavation at widest point of manhole, chamber, or vault shall be not wider than two feet greater than widest outside dimension (including bottom footings or flanges, if any, of precast concrete structures) of the associated manhole, chamber, or vault.

d. Trench width shall be sufficient for Contractor's means of temporarily supporting the excavation and dewatering.

e. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.

f. Do not use construction equipment or machinery that necessitates trench to be excavated to excessive width.

3. Depth of trench shall be as shown or indicated in the Contract Documents. If required and approved by Engineer in writing (such as a duly issued Contract modification), depths may be revised.

4. Where Engineer considers existing subgrade (beneath intended bedding material) unsuitable, remove and replace such unsuitable material with [granular structural fill] material for full width of trench, down to suitable material.

G. Freeze Protection:

1. Do not place foundations or fill material on frozen subgrade.

2. When freezing temperatures are expected, based on widely recognized, reputable source for weather forecasts at or near the Site, do not excavate to full depth indicated, unless foundations or fill material can be placed immediately after excavation has been completed and is acceptable in accordance with the Contract Documents.

3. Protect from freezing excavation, subgrade, and fill materials when subsequent Work thereon is delayed.

H. Construction Traffic on Soils:

1. Furnish and use appropriate backhoe or other low-contact pressure equipment to remove existing materials.

2. Minimize construction traffic on existing materials and saturated soils and avoid soil disturbance.

3. Repair disturbed subgrade materials prior to performing subsequent Work. Remedial work shall be in accordance with the Contract Documents. When not addressed in the Contract Documents, remedial Work shall be as directed by Engineer via appropriate Contract modification.

4. Allow only minimal foot traffic on bearing soils prepared for subsequent installation of fill or foundations.

3.6 FILLING AND COMPACTING

A. Filling and Compacting – General:

1. Provide and compact all fill required for the finished grades as shown and as indicated in this Section.

B. Place fill as promptly as progress of the Work allows, but not until completing the following:

1. Obtaining Engineer's concurrence, after observation by Engineer or Resident Project Representative (if any) of construction below finish grade, including removal of trash and debris from excavations, waterproofing (where required), and related Work.

2. Successful completion of required field quality control activities for Work that will be covered or concealed by filling, including field quality control testing of buried piping, conduits that will convey fluid or gas, and exfiltration testing (where performed or required) of manholes, chambers, vaults, and similar items. For manholes, chambers, and vaults, where infiltration testing or vacuum testing is performed or required, such testing may be performed following backfilling.

3. Completion of proper documentation of as-constructed conditions and existing conditions (such as locations of Underground Facilities) in accordance with Section 01 78 39 - Project Record Documents.
4. Removal of temporary supports of excavations.
5. Remove fill that includes organic materials or other unacceptable material and replace with fill material complying with the Contract Documents.

C. Placement – General:

1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around manholes, chambers, vaults, and similar items, and Underground Facilities.
2. Management of Moisture Content:
   a. Place fill materials at moisture content and density as indicated in this Article's requirements on compaction density. Prior to placing fill material, optimum moisture and maximum density properties for proposed material shall be obtained from Engineer, who may consult with geotechnical consultant, if any. Furnish and use construction equipment and machinery capable of adding measured amounts of water to fill materials to bring fill materials to a condition within required moisture content range. Control moisture for each lift necessary for required compaction.
   b. Furnish and use construction equipment and machinery capable of discing, aerating, and mixing fill materials to ensure reasonable uniformity of moisture content throughout fill materials, and to reduce moisture content of borrow materials by air drying, when necessary.
   c. When subgrade or fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted.
   d. Materials at moisture content in excess of specified limit shall be dried by appropriate means, such as aeration or stockpiling for gravity drainage and air drying.
3. Compaction:
   a. Compaction Equipment:
      1) Perform compaction with construction equipment and machinery suitable for the type of fill material placed. Unless otherwise required, compact cohesive soils using sheepsfoot compactor, and compact granular materials using pneumatic rollers, vibrators, or other construction equipment or machinery to obtain required density.
      2) Select and use equipment capable of providing the minimum density required in the Contract Documents.
      3) Use light compaction equipment and machinery, with equipment or machinery gross weight not exceeding 7,000 pounds within horizontal distance of 10 feet from the wall of completed, below-grade manholes, chambers, vaults, and similar items, and walls of adjacent buildings or structures.
      4) Furnish and use construction equipment and machinery capable of compacting in restricted areas next to structures and around piping and Underground Facilities.
   b. Compaction Test Area:
      1) Effectiveness of construction equipment and machinery selected by Contractor for compacting, shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed.
      2) If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the quantity of coverages, decrease the lift thicknesses, or use different compactor equipment or machinery.
4. Placement of Lifts and Compaction:
   a. Place fill materials in horizontal, loose lifts, not exceeding specified thickness prior to compacting.
   b. Place fill in manner ensuring uniform lift thickness after placing.
   c. Preparation of surfaces for placement of fill:

1) Before commencing placing of fill, scarify underlying material to depth of six inches.
2) Where ground surface is steeper than one vertical to four horizontal ("1V:4H"), plow surface to bench and break up surface so that fill material will bind with existing surface. For slopes steeper than 1V:4H and less than 1V:1.5H, bench shall be six feet wide. For slopes steeper than or equal to 1V:1.5H and less than 1V:0.5H, bench shall be four feet wide.

d. Mechanically compact each lift, by not less than two complete coverages of compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface.

e. Compaction of fill materials by inundation with water is unacceptable.

5. Restrictions:

a. Do not place fill materials when standing water is present on surface of area where fill will be placed.

b. Do not compact fill when standing water is present on the fill to be compacted.

c. Do not place or compact fill in frozen condition or on top of frozen material.

d. Fill containing organic or deleterious materials or other unacceptable material previously described shall be removed and replaced prior to compaction.

6. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment or machinery, perform all work necessary to provide required densities. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.

7. Repair, at Contractor's cost, observed or measured settlement. Make repairs and replacements as necessary and required within 30 days after being so advised by Engineer, unless more-timely action is necessary to avoid or reduce the potential for safety hazards or damage to property.

D. Fill Placed in Pipe Trenches:

1. Piping trenches may be backfilled prior to testing of piping, unless nature of test requires observation of pipe or manholes, chambers, vaults, or similar items during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.

2. Pipe Bedding: Pipe bedding material shall be as follows:

a. Unless otherwise shown or indicated, install buried piping on not less than six-inch layer of aggregate pipe bedding material underneath piping.

b. Pipe bedding material shall extend upward from elevation required immediately above to horizontal centerline of associated buried piping.

c. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints.

d. Install initial layer of pipe bedding material on prepared subgrade and compact as required. Provide appropriate divot in the bedding material to accommodate each pipe bell or joint. Install piping so that pipe barrel carries the weight of each pipe segment, rather than pipe bells or joints bearing the pipe's weight.

e. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.

f. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of pipe and back of bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations.

g. Subsequent to forming pipe joint, place additional pipe bedding material, in required lifts, to required top elevation of pipe bedding material. Ensure bedding material is

properly and fully placed under pipe “haunches” for proper support of piping. Compact lifts of pipe bedding material in accordance with this Article prior to placing subsequent backfill material.

3. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placing and compacting of pipe trench fill materials shall comply with the following:
   a. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping.
   b. Each layer of pipe trench fill material shall be compacted by not less than two complete coverages of all portions of surface of each lift using appropriate compaction equipment or machinery.
   c. Method of compaction and compaction equipment and machinery used shall be appropriate for material to be compacted and shall not transmit damaging shocks to piping.

E. Installation of Flowable Fill, also known as Controlled Low Strength Material (CLSM):
   1. Discharge flowable fill from ready-mix delivery vehicle into excavation, or other space to be backfilled with such material, via chutes, pumping, or hand-carried in buckets, in accordance with the Contract Documents (including the Specifications of Division 03 - Concrete) and requirements of flowable fill ready-mix Supplier.
   2. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
   3. Place flowable fill in lifts not greater than four feet depth.
   4. Placing of each lift of flowable fill shall be a continuous operation, to the extent practicable.
   5. Place flowable fill in manner that prevents flotation of piping or other damage to the Work, other Underground Facilities, and adjacent property.
   6. Cold Weather Placing:
      a. Do not place flowable fill on frozen subgrade.
      b. Flowable fill batching, mixing, and placing may be performed when weather conditions are favorable, and ambient air temperature is 34 degrees F and rising.
      c. At the time of placing, flowable fill must have a temperature of not less than 40 degrees F.
      d. Discontinue placing flowable fill when ambient air temperature is 38 degrees F or less and falling.
   7. After placing flowable fill, allow not less than 12 hours before placing subsequent lift or approved otherwise by Engineer.
   8. Prevent contact with flowable fill by construction vehicles and equipment, or other traffic, for not less than 24 hours after placing, or until flowable fill is sufficiently hard to prevent rutting or other damage by vehicles and construction equipment.

F. Fill Required Under Subbase for Pavement and Other Traveled Ways:
   1. Where bottom of pavement or surfacing of other traveled way will be at elevation equal to or less than preconstruction ground surface, after required excavation and preparation of subgrade, provide required subbase material to required depth. At underside of pavement or other surfacing of traveled way, subbase material shall extend horizontally six inches beyond edges of pavement or other surfacing. Exterior edges of subbase material shall be placed and compacted at uniform slope of one foot vertical-to-one foot horizontal away from top edge of subbase down to subgrade.
   2. Where bottom of pavement or surfacing of other traveled way will be at elevation greater than preconstruction ground surface, after required preparation of subgrade, provide required fill material and subbase material to required depth. At underside of pavement or other surfacing of traveled way, subbase material shall extend horizontally six inches beyond edges of pavement or other surfacing. Exterior edges of subbase material and fill material shall be placed and compacted at uniform slope of one foot vertical-to-one foot horizontal away from top edge of subbase down to subgrade.

G. Compaction Density Requirements:

1. See Section 31 23 33 – Excavation and Fill

H. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with granular structural fill material and thoroughly compact in accordance with applicable table in this provision. Slope the sides of excavation in accordance with the maximum allowable inclinations specified for each element of the Work.

3.7 UNAUTHORIZED EXCAVATION

3.8 DISPOSAL OF EXCAVATED SPOIL MATERIALS

A. Spoil Disposal - General:

1. Contractor shall haul away excavated material that does not comply with requirements for fill, or is in excess of quantity required for fill.
2. Disposal of materials shall comply with Laws and Regulations, at no additional cost to Owner.

3.9 FIELD QUALITY CONTROL

A. Site Tests and Inspections:

1. Testing Laboratory:
   a. Employ a testing laboratory to perform field quality control testing.
   b. Testing Laboratory Scope:
      1) Perform field moisture content tests (in accordance with ASTM D2216 or ASTM D6938) and density tests (in accordance with ASTM D1556 or ASTM D6938) to verify that required compaction of fill materials was provided.
      2) Tests of actual unconfined compressive strength or bearing tests (in accordance with ASTM D2850 or ASTM D2166) on each stratum.
      3) Furnish to Engineer and Contractor written results of each test.
   c. Authority and Duties of Testing Laboratory:
      1) Testing laboratory representatives (“technician”) shall inspect the materials in the field, perform testing, and report findings to Engineer and Contractor. When the Work is defective, technician will direct attention of Engineer and Contractor to such defective Work.
      2) Technician shall not supervise performance of any of Contractor’s Work. Technician shall not perform other duties for Contractor.
      3) Work will be tested and inspected by testing laboratory as the Work progresses, but failure to detect defective Work (including defective materials) shall not, in any way, prevent later rejection when defect is discovered, nor shall it obligate Engineer for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
2. Responsibilities and Duties of Contractor:
   a. Use of testing laboratory or geotechnical consultant in no way relieves Contractor of responsibility to provide Work in compliance with the Contract Documents.
   b. When Owner furnishes services of testing laboratory, geotechnical consultant, or any combination thereof, for trenching, backfilling, and related earth Work, Owner and Engineer do not represent that the sampling and testing performed by Owner-hired testing laboratory or observations by Owner-hired geotechnical consultants, is sufficient for Contractor’s purposes, or to monitor all aspects of the trenching, backfilling, and related earth Work. If additional quality control is needed to verify that the Work performed and materials delivered to the Site are in accordance with the Contract

Documents, Contractor may retain its own, independent testing laboratory to perform additional sampling and testing for Contractor's purposes.

c. To facilitate testing laboratory and geotechnical consultant, Contractor shall advise testing laboratory and geotechnical consultant not less than two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.

d. Contractor shall be responsible for providing required compaction for fill and other earthwork. Contractor shall control construction operations by performing confirming tests to verify that Contractor has complied with the Contract Documents relative to compaction and moisture content.

e. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.

1) 200 linear feet of trench fill.

2) 10 cubic yards of granular structural fill.

3) 100 cubic yards of suitable soil material.

4) 50 cubic yards of subbase material.

3. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be as follows:

a. Trenches for Underground Facilities (including buried ductbanks):

1) In Open Fields: Two locations every 1,000 linear feet.

2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.

3) Crossing Paved Roads: Two locations along each crossing.

4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.

b. For granular structural fill: Once per lift for each 1,000 square feet placed and compacted.

c. For soil structural fill:

1) For backfilling trenches directly adjacent to buildings or structures, on 30-foot intervals on all sides of the building or structure for every compacted lift, but not less than one per lift on each side of the building or structure for buildings or structures less than 60 feet long on a side.

2) For material not used as fill against buildings or structures, once per lift for each 1,000 square feet placed and compacted.

d. For Suitable Soil Material: One per 1,000 square feet on every compacted lift.

e. Subbase Material: One per 1,000 square feet on every compacted lift.

4. Periodic compliance tests will be made by Engineer to verify that compaction is in accordance with the Contract Documents, at no cost to Contractor. Contractor shall remove overburden above the level at which Engineer wishes to test and shall fill and re-compact the material after testing is complete.

B. Defective Work:

1. If testing laboratory reports or inspections indicate subgrade, fill, or bedding compaction less than specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's cost until subgrades, bedding, and fill are acceptable.

2. Costs for retesting of subgrade, fill, or bedding materials that did not originally comply with the Contract Documents, including required density, shall be paid by Contractor.

3.10 RESTORATION

A. Restoration – General:

1. Perform finish grading, including providing topsoil, in accordance with Section 31 22 19 - Finish Grading.
2. Provide replacement paving, sidewalks, curbs, gutters, and similar items in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.
3. Restore landscaping including lawn and meadow areas, in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.

END OF SECTION

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DIVISION 32

EXTERIOR IMPROVEMENTS

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SECTION 32 13 13
CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Reinforced, “traditional” Portland cement concrete paving.
2. Surface treatment applied to hardened concrete pavement.
3. Construction joints in concrete pavement.
4. Expansion joints (also known as “pressure relief joints”) and isolation joints in concrete pavement, together with associated joint sealants.

B. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 31 19 – Project Meetings
2. Section 03 01 30 - Repair and Rehabilitation of Existing Construction.
3. Section 03 05 05 - Concrete Testing and Inspection.
4. Section 03 11 13 - Formwork.
5. Section 03 21 00 - Reinforcement.
6. Section 03 31 30 - Concrete, Materials and Proportioning.
7. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
8. Section 31 23 33 - Trenching and Backfilling.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:

1. Concrete paving Work is part of the lump sum bid/pay item indicated on the Bid Form, and part of the Contract, and in Section 01 22 00 - Measurement and Payment.
2. Measurement of concrete paving Work for payment will be in accordance with Section 01 29 73 - Schedule of Values, and other relevant provisions of the Contract Documents.

B. Payment Adjustment for Deficient Thickness of Concrete Pavement:

1. When thickness of new concrete paving provided is determined, based on requirements of this Section’s “Field Quality Control” Article to be more than 0.25-inch less than thickness required by the Contract Documents, and less than 0.5-inch less than the thickness required by the Contract Documents, unless there is other basis for Engineer to reject the new concrete paving as defective Work, Engineer will accept the subject concrete paving upon an associated reduction in the Contract Price. Such reduction in the Contract Price shall be determined as indicated in this provision.
2. Reduction in the Contract Price will be limited to Contractor’s compensation for new concrete paving, compensated on a lump sum basis, as indicated in the Schedule of Values. Such consideration will not consider subbase thickness.
3. cases, be for the full width of the associated lane or lane-equivalent for which field quality control activities determined concrete pavement to be of thickness less than required by the Contract.
4. Owner or Engineer may set-off such reductions from amounts due Contractor under the Contract.
5. Reduction of Contractor’s compensation for new concrete paving shall be as indicated in the following table:

Deficiency in Depth Determined by Cores inches	Proportional Part of Contract Price Allowed
0.0 to 0.25	100%
0.26 to 0.30	95%
0.31 to 0.35	90%
0.36 to .040	85%
0.41 to 0.45	80%
0.46 to .050	70%
Greater than 0.50	Defective Work

1.3 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
   a. “Average pavement thickness” means the weighted average of the acceptable pavement, taking into consideration the length of the pavement after eliminating defective pavement Work.
   b. “Concrete” means Portland cement concrete, in accordance with the Specifications of Division 03 - Concrete. In this Section, the term, “concrete” does not mean asphalt concrete used in flexible paving, unless the term “asphalt concrete”, is expressly indicated.
   c. “Milling” means shaping and removing portions of existing surfaces by the cold milling process and subsequent cleaning.
   d. “Subbase” means the layer of compacted aggregate material installed on either the subgrade or, when required, geotextile separation fabric. Concrete paving is subsequently installed on top of subbase, unless new concrete paving is expressly required to be installed over other, existing pavement to remain.
   e. “Subgrade” means the uppermost surface of native soil material unmoved from cuts; the bottom of excavation on which either geotextile or subbase is installed.

B. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M31 - Standard Specification for Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement (ASTM A615/A615M).
   b. M153 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction (ASTM D1752).
   c. M213 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types) (ASTM D1751).
   d. M224 - Standard Specification for Use of Protective Sealers for Portland Cement Concrete.
   e. M233 - Standard Specification for Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
2. ASTM International (ASTM):
   a. A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement (AASHTO M31).
   b. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

c. A996 - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
d. C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
e. C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
f. C42/C42M - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
g. C78/C78M - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
h. C138/C138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
i. C174/C174M - Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores.
j. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Asphalt Types) (AASHTO M213).
k. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction (AASHTO M153).
l. D3666 - Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials.
m. D6690 - Standard Specification for Joint and Crack Sealants.
n. E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

3. Federal Specification (FS):
   a. TT-B-1325D - Beads (Glass Spheres) Retro-Reflective.
   b. TT-P-1952F - Paint, Traffic and Airfield Marking, Waterborne.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Review installation procedures under this and other Specifications and coordinate installation of items that must be installed with, or before, concrete paving Work.

B. Notify other contractors, utility owners, and owner's of transportation facilities (as applicable) in advance of installing concrete paving to provide such other entities with sufficient time for installing items included in their contracts or projects, as applicable, that must be installed with, or before, concrete paving Work.

B. Pre-installation Conference:

1.5 DISCUSS AND COORDINATE IN ACCORDANCE WITH SECTION 01 31 19 – PROJECT MEETINGS. QUALITY ASSURANCE

A. Regulatory Requirements:

   .

   1. Areas requiring concrete paving Work are owned and under the jurisdiction of Owner, unless indicated otherwise elsewhere in the Contract Documents.

B. Qualifications:
   1. Ready-mix Concrete Supplier:
      a. Comply with requirements of Section 03 00 05 - Concrete Section 03 31 31 - Concrete, Mixing, Placing, Jointing, and Curing.
   2. Installer of Concrete Paving:

a. Installer shall be experienced in providing concrete paving of the types required for the Project, and experienced in providing concrete paving in quantities similar to, or greater than, those required for the Project.

b. Upon Engineer's request, submit documentation of the proposed installer's compliance with qualifications requirements of this Article.

1.6 SUBMITTALS

A. Submittals Required Under Other Sections:

1. In addition to Submittals required in this Section, furnish Submittals required by the Specifications of Division 03 - Concrete, including, but not necessarily limited to, the following:

   a. Concrete materials and supplemental materials, such as admixtures and curing compounds. Mixes for concrete paving are specified under this Section.

   b. Reinforcing steel required for concrete paving may be submitted under this Section, but shall comply with requirements for reinforcing steel Submittals as indicated in the Specifications of Division 03 - Concrete.

   c. Joint locations. Shop Drawings and product data Submittals for joint materials and sealants for concrete paving shall be submitted under this Section.

   d. Delivery tickets.

   e. Field quality control Submittals. Additional requirements for field quality control Submittals specific to concrete paving are indicated in this Section.

B. Action Submittals: Submit the following:

1. Shop Drawings:

   a. Mix designs for concrete paving, in accordance with requirements for mix design Submittals indicated in the Specifications of Division 03 - Concrete, but demonstrating compliance with mix design required in this Section.

   b. Drawings showing and indicating locations of concrete pavement joints, including longitudinal joints and transverse joints, including construction joints and expansion joints (pressure relief joints), and isolation joints. Submit details of each type of joint required, including details for unique conditions.

2. Product Data: For each item or material specified in this Section, submit manufacturer's published product information, including indication of materials, performance requirements, compliance with reference standards indicated in this Section, manufacturer's published specifications, application rates, manufacturer's written instructions for storage, preparation, and installation, and similar information.

   a. Surface treatment material applied to new concrete pavement.

   b. Expansion joint and isolation joint materials, including sealants.

3. Samples

   a. Samples of fabricated jointing materials, when requested by Engineer. When furnished, such Samples shall be of sufficient size to demonstrate materials, color, texture, arrangement, features, thickness, and height of joint materials proposed for use.

C. Informational Submittals: Submit the following:

1. Special Procedure Submittals:

   a. Submit manufacturer's description and characteristics for traveling form paver, if proposed for use.

   b. Engineer's review, comments, and acceptance of special procedure Submittals required is not for Contractor's benefit and, in no way reduces or mitigates Contractor's sole responsibility for construction means, methods, techniques, procedures, and sequences, and associated safety and protection measures.

2. Field Quality Control Submittals:

a. Submit written results of required field quality control tests and inspections, in accordance with the Specifications of Division 03 - Concrete.
b. Submit written results of required field quality control tests and inspections required in the “Field Quality Control” Article of this Section.

3. Qualifications Statements:
   a. Concrete ready-mix Supplier: In addition to documentation of qualifications requirements in the Specifications of Division 03 - Concrete, submit documentation of compliance with qualifications requirements of this Section:
   b. Installer, when requested by Engineer.

1.7 FIELD CONDITIONS

A. Restrictions on temperature and weather conditions for installing concrete paving are indicated in the Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.

PART 2 - PRODUCTS

2.1 CONCRETE PAVING – GENERAL

A. Description:
   1. Provide all labor, materials, construction equipment and machinery, tools, services, and incidentals necessary and required to furnish and install Portland cement concrete paving.
   2. Provide concrete paving at locations shown on the Drawings. When locations of concrete paving are not shown, provide concrete paving to restore areas where concrete paving existed on the Effective Date of the Contract where such areas were disturbed, damaged, or removed by Contractor.
   3. This Section does not address concrete curbing, gutters, sidewalks, or concrete driveway aprons, which are, when part of the Work, addressed under other sections of the Specifications.

2.2 CONCRETE PAVING MATERIALS SPECIFIED ELSEWHERE

A. Requirements for materials for concrete paving are generally indicated in the Specifications of Division 03 - Concrete, unless expressly indicated in Article 2.2 of this Section. Items and materials required for concrete paving indicated in the Specifications of Division 03 include, but are not necessarily limited to, the following:
   1. Portland cement.
   2. Aggregates.
   3. Water used in concrete mixes and installation.
   4. Admixtures.
   5. Reinforcing steel.
   6. Waterstops.
   7. Membrane-Forming Curing Compound.
   8. Temporary cover materials for curing concrete.

2.3 CONCRETE PAVING MATERIALS AND MIXES

A. Expansion Joint (Pressure-Relief Joint) and Isolation Joint Filler Material.
   1. Filler material is required in transverse joints in concrete pavement, as a means of controlling cracking caused by temperature and other movement (i.e., expansion joints). In addition, filler material is typically required between concrete pavement and adjacent items or features, where it may be called “isolation joints”. Isolation joints are typically required between concrete paving and manhole cover frames, valve boxes, stormwater inlets, curbing, gutters, and the like.
   2. Provide, at Contractor’s option, non-extruding cork, self-expanding cork, sponge rubber, or cork rubber. Joint filler modified to include polyurethane bonded recycled rubber, consisting

of preformed strips of a durable composite of ground recycled rubber from automobile tires bonded together with polyurethane adhesive, is acceptable.

3. Comply with AASHTO M153 (ASTM D1752) or AASHTO M213 (ASTM D1751).
4. Size Requirements:
   a. When provided for transverse joints, as well as isolation joints, provide lengths equal to width of traffic lane or ramp with thickness of not less than one inch. Provide smooth top surface and holes punched for reinforcing dowels, providing a snug fit without loss in thickness of joint filler material.
   b. When provided for longitudinal joints, provide continuous filler joint material, in lengths of not less than eight feet, and join securely.

B. Joint Sealants for Expansion Joint (Pressure-Relief Joint) and Isolation Joint Filler Material.

1. At Contractor's option, provide one of the following types of joint sealant material for expansion joints (pressure relief joints) and isolation joints. Joint sealant provided shall be compatible with joint filler material to which it is applied.
2. Silicone Joint Sealing Material:
   a. Roadsaver Non-Sag Silicone (34902), by Crafco.
   b. DOWSIL 888 Silicone Joint Sealant, by Dow Chemical.
   c. Pecora 301 NS, by Pecora.
   d. Sikasil 728 NS, by Sika.
   e. Spectrem 800 Low Modulus Silicone, by Tremco Construction Products Group.
   f. Or equal.
3. Rubberized Joint Sealing Material (ASTM D6690-Type II and IV)
   a. Greyseal 6690 (Color: Grey), by FPT Infrastructure.
   b. Elastoflex 410, Maxwell Products.
   c. MACSEAL 6690, McAsphalt Industries.
   d. 3405, by W. R. Meadows.
   e. RoadSaver 231, or RoadSaver 221, or Flex-A-Fill 9005, or Deery 102, or Deery 101, by Crafco
   f. Or equal.
4. Rubberized Joint Sealing Material (ASTM D6690-Type I)
   a. Greyseal 6690 (Color: Grey), by FPT Infrastructure.
   b. Elastoflex 61, Maxwell Products.
   c. MACSEAL 6690, McAsphalt Industries.
   d. Dura-Fill 1190, by P &T Products.
   e. RoadSaver 111 or Deery 103, by Crafco
   f. Or equal.
5. Preformed Neoprene Compression Seals: Provide both sealant material and lubricant adhesive as follows:
   a. Sealant Material:
      1) E-1006, or E-816, or V-1625 Delastic Preformed Pavement Seal, by D. S. Brown.
      2) Or equal.
   b. Lubricant Adhesive:
      1) DSB 1520 Lubricant Adhesive, by D. S. Brown.
      2) Adhesive Lubricant 105 or Lube Plus 4070, by ChemMasters.
      3) Or equal.
6. Preformed Closed Cell Polyethylene Joint Filler
   a. Preformed Closed Cell Polyethylene Joint Filler, by W. R. Meadows.
   b. Or equal.

7. Asphalt Rubber Sealing Compound
    a. Elastoflex 650, Maxwell Products.
    b. MACSEAL AR, by McAsphalt Industries.
    c. Dura Fill 5078, by P & T Products.
    d. Asphalt Rubber Type 2, Part No. 34232, or PolyFlex 601, or PolyFlex Type 2, Part No. 34518, or Deery 5078, by Crafco.
    e. Or equal.
8. Accessories: In addition to joint sealant, provide the following:
    a. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
    b. Sealant backer rod or compressible filler: Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by joint sealant manufacturer to perform the following: control joint depth, break bond of sealant at bottom of joint, provide proper shape of sealant bead, and serve as expansion joint filler.

C. Concrete Surface Treatment Material:
1. Provide boiled linseed oil mixture complying with AASHTO M233.

D. Mixes
1. Provide concrete for concrete paving with the following characteristics:
    a. Compressive strength: not less than 4,500 psi at 28 days. Test specimens shall be prepared in accordance with ASTM C31 and testing for compressive strength shall be in accordance with ASTM C39.
    b. Flexural strength: not less than 500 psi at seven days, and 600 psi at 28 days. When high-early-strength cement is provided, flexural strength shall be not less than 550 psi at seven days, and 600 psi at 28 days. Test specimens shall be prepared in accordance with ASTM C31 and testing for flexural strength shall be in accordance with ASTM C78.
    c. Coarse, dry aggregate shall not exceed 85 percent of loose volume of concrete.
    d. Slump: Not less than one inch and not greater than four inches, unless otherwise indicated based on type of concrete placing equipment used.
    e. Air Content: five to seven percent air by volume.
    f. Water-to-Cement Ratio: 0.37 to 0.45.
    g. Cement Content per Cubic Yard: 517 to 611 pounds.
2. Unless otherwise required in this Section, Concrete mixes for concrete paving shall comply with the following:
    a. Section 03 31 30 - Concrete Materials and Proportioning, and Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
1. Examine subbase and base on which concrete paving will be installed.
2. Advise Engineer in writing of conditions detrimental to proper and timely completion of the Work.
3. Do not proceed with concrete paving Work until unsatisfactory conditions are corrected.

B. Installing the Work constitutes Contractor's approval of underlying work, surfaces upon which concrete paving will be installed, and field conditions prevailing at the time of the Work.

3.2 PREPARATION

A. General Preparation: Before starting installation of concrete paving, perform the following:

1. Grade Control: Establish and maintain throughout concrete paving Work required lines and grades, including crown and cross-slope during construction.
2. Coordinate placement of concrete paving with new and existing curbs, gutters, sidewalks, drainage structures (such as catch basins, drop inlets, and similar items), manholes and associated frames and covers, valve boxes and associated covers, sensors and similar devices associated with traffic controls, signage, pavement markings and markers, and similar items. Where necessary, adjust rim elevations of manhole frames and covers, valve boxes and covers, and stormwater drainage inlets within areas of concrete paving Work to required final elevations.
3. Provide appropriate maintenance and protection of traffic measures during pavement installation and related Work.

B. Subgrade and Subbase:

1. Prepare subgrade and provide subbase for concrete paving in accordance with 31 23 33 - Trenching and Backfilling. Before installing concrete paving Work, obtain Engineer's concurrence that subgrade and subbase are suitable for installing concrete paving.

C. Surface Preparation:

1. Where new concrete paving will abut existing paving, sawcut edges of existing paving in accordance with the "Installation" Article of this Section.
2.

3.3 INSTALLATION

A. Installation Requirements:

1. Concrete Paving Installation – General:
   a. Unless indicated otherwise elsewhere in this Section, this Article applies to installation of new concrete pavement.
   b. Unless indicated otherwise in this Section, comply with concrete installation requirements in the Specifications of Division 03 - Concrete.
   c. Provide final surfaces of concrete pavement with uniform texture, at required locations and grades, with required cross-sections, as shown and indicated.
   d. Where new concrete pavement is provided and connects to existing pavement, provide new concrete surface that smoothly and evenly transitions to existing paved surfaces and grades.
2. Sawcutting of Edges:
   a. Where new concrete pavement will meet existing pavement, existing pavement shall be sawcut.
   b. Furnish and use saw with diamond-tipped blade, blade guard, alignment guides, water cooling system, and cut-depth controls for saw cutting.
   c. Do not allow cooling water, slurry, and dust from sawing to enter any lane opened to traffic.
   d. Edges of existing pavement shall be cleanly cut. Edges shall be linear and have vertical cut face.
   e. Do not break back underside of existing pavement. If break back or spalling occurs, make new full depth transverse sawcut beyond area of break back or spalling. Provide full-depth replacement concrete pavement at Contractor's cost.
   f. Sawcutting of concrete pavement, concrete curbs, concrete gutters, and sidewalks shall comply with Section 01 73 29 - Cutting and Patching.
3. Construction Equipment and Machinery:
   a. Subbase Planer:
      1) Furnish and use subbase planer with adjustable cutting blades to trim subbase to exact section shown on the Drawings.
      2) Mount planer on visible rollers that ride on forms.

3) Planer frame shall have sufficient weight to remain on forms, and shall possess strength and rigidity that, under tests made by changing support from wheels to center, planer shall not deflect more than 1/8-inch.
4) Equipment used for pulling planers shall not produce ruts or indentations in subbase.
5) When slip-form paving is performed, operate subbase planer on prepared, graded track, or control planer using electronic sensor system operated from string line, to establish horizontal alignment and elevation of subbase.

b. Subbase Template:
1) Provide template for checking contour of subbase.
2) Template shall be of sufficient length to rest on side forms and shall have sufficient strength and rigidity, when supported at center, so that deflection shall not exceed 1/8-inch.
3) Provide template with accurately adjustable rods projecting downward at one-foot intervals. Adjust rods to gauge cross-sections of bottom of concrete when template is resting on side forms.

c. Machine Finisher:
1) Furnish and use power-driven, transverse finishing machine designed and operated to strike off and consolidate concrete.
2) Machine shall have two screeds accurately adjusted to required crown of pavement and with frame riding on forms.
3) Furnish and use finishing machine with rubber tires when operating on concrete pavement.

d. Hand Finishing:
1) Provide mechanical strike and tamping template two feet longer than width of pavement to be finished. Shape template to required pavement section.
2) Provide two bridges, riding on forms, spanning pavement for finishing expansion joints and construction joints. Provide floats and necessary edging and finishing tools.

e. Burlap Drag for Finishing Concrete:
1) Furnish and use four plies of 10-ounce burlap material fastened to bridge, forming continuous burlap strip across full width of pavement. Three foot width of burlap material shall contact concrete surface across full width of lane or pavement.
2) Keep burlap drags clean and free of encrusted concrete material.

f. Vibrators:
1) Furnish and use mechanically operated, synchronized vibrators mounted on tamping bar, riding on forms, and hand-manipulated mechanical vibrators.
2) Furnish and use vibrators with frequency of vibration to provide required consolidation of concrete without segregation of concrete's constituents.

g. Traveling Form Paver:
1) Traveling form paver, suitable for use on projects of the state department of transportation having jurisdiction at or adjacent to the site, may be used in lieu of construction methods requiring forms, and consolidating, finishing, and floating equipment as otherwise required in this Section.
2) When traveling form paver does not provide concrete paving in accordance with requirements of the Contract Documents, immediately discontinue using such equipment and perform the Work using conventional construction equipment, machinery, and methods.
3) When used, traveling form paver shall have longitudinal transangular finishing float adjustable to required crown and grade. Float mechanism shall be of sufficient length to extend across pavement to side forms or edge of concrete. Traveling form paver shall continuously deposit concrete to minimize starting and stopping.

4) Use conventional construction equipment, machinery, and methods to provide concrete paving at locations inaccessible to traveling form pavers, and for concrete paving with required horizontal or vertical curvature that precludes using traveling form pavers.

5) Where tie bars are required for adjacent paving, securely tie and support bars to prevent displacement. Installing tie bars using mechanical bar inserter installed on traveling form paver is acceptable. Replace concrete paving provided as part of the Work where tie bars' final position is other than that required by the Contract Documents.

4. Forming:

a. Unless otherwise indicated in this Section, formwork shall comply with Section 03 11 13 - Formwork.

b. Side Forms:

1) Furnish and use metal forms of acceptable shape and section. Aluminum forms are unacceptable. Forms eight inches or more high shall have width, at base, not less than eight inches.

2) Depth of form shall be equal to required edge thickness of pavement.

3) Forms with depths greater or less than required edge thickness are acceptable, provided difference between form depth and required edge thickness when such vertical difference is not greater than one-inch. Forms with depth less than required thickness of pavement edge are acceptable when (a) vertical difference between top of form and required concrete surface at pavement edge is not greater than one-inch, and (b) required thickness of edge of pavement can be provided by providing securely attaching temporary wood or metal strips to bottom of form, or by grouting under form.

4) Maximum deflection: 1/8-inch under center load of 1,700 pounds.

5) Thickness: Not less than 7/32-inch thick.

6) Top: Flat or rounded, not less than 1.75-inches wide.

7) Bottom flange of form shall be same size as required thickness of edge of pavement.

8) Length of form sections shall be not less than 10 feet. Each section of forms shall provide for staking at required position using not less than three temporary pins.

9) Furnish and use flexible spring steel forms or laminated boards for forming radius bends. Furnish and use curved forms of wood or metal, of proper radius, for curves of 200-foot radius and less. Provide sufficient forms for satisfactory placement of concrete. For short radius curves, forms less than 10 feet in length or curved forms may be used.

10) Forms shall have sufficient strength and possess adequate devices for secure, temporary installation, so that, when installed forms shall withstand, without visible springing or settling, impact and vibration of finishing machine and other construction-related stresses to which they will be subjected.

11) Forms shall be free from warp, bends, and kinks. Forms shall be sufficiently true to provide straight edge on concrete. Top of each form section, when tested with straight edge, shall comply with requirements specified for surface of completed pavement.

c. Installation of Forms:

1) Install forms directly on subbase. Do not adjust forms to required elevation using matter such as stones, earthen material, or similar items. Accurately set forms to required elevation, grade, and alignment. During concrete installation and finishing, forms' installed location shall not deviate more than 1/8-inch in 10 feet from required location.

2) Do not remove forms for at least eight hours after completing finishing of installed concrete. Provide sufficient quantity of forms for orderly and continuous placing of

concrete. Install forms and verify proper location, elevation, and alignment for 300 feet ahead of concrete installation, unless otherwise acceptable to Engineer.

3) Adjacent, existing concrete that will abut the required concrete upon completion may be used in lieu of temporary forms, provided that existing concrete is properly protected from potential damage by finishing equipment. When new concrete will be placed adjacent to other concrete Work provided as part of the Project, adjacent concrete shall not be used in lieu of temporary forms until such adjacent concrete is not less than seven days old.

5. Reinforcing:
   a. Unless otherwise indicated in this Section, reinforcing shall comply with Section 03 21 00 - Reinforcement.
   b. Provide reinforcing steel, securely installed as shown and indicated on the Drawings. Locate longitudinal edge bars between three and six inches from edge of slab.
   c. At intersections and splices of reinforcing steel, wire reinforcing bars securely together. Lap nonwelded bars not less than one foot.
   d. Securely tie ends of transverse reinforcing of upper layer of reinforcing to prevent curving.
   e. Lap pavement slabs one full space.
   f. Bars and coatings shall be free of rust, dirt and other foreign matter when concrete is placed.
   g. Properly vertically support reinforcing steel using “chairs” in accordance with the Specifications of Division 03 - Concrete.
   h. Provide sufficient quantity of “chairs” supporting reinforcing to maintain position of bars within allowable tolerances. In plane of steel parallel to nearest surface of concrete, reinforcing shall not vary from required locations by more than 1/12 of spacing between bars. In plane of steel perpendicular to nearest surface of concrete, reinforcing shall not vary from required locations by more than 1/4-inch.
6. Joints:
   a. Joints – General:
      1) Unless otherwise indicated in this Section, joints in concrete paving shall comply with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
      2) Provide joints at locations shown or indicated in the Contract Documents. When approved Shop Drawings indicate deviations from locations of joints shown or indicated in the Contract Documents, obtain from Engineer appropriate Contract Modification, such as a Field Order, before proceeding with installing joints. Provide joints at locations and alignment to within 1/4-inch of that required.
      3) Position pavement joint assemblies at required locations and elevations, and rigidly secure in position. Secure in required position to prevent displacement during placing and finishing of concrete.
      4) Provide dowel bars in joint assemblies, each parallel to pavement surface and to center line of pavement, as shown, except in isolation joints.
      5) Cut header boards, joint filler, and other material used for forming joints as necessary for each dowel bar.
      6) Drill dowels into existing pavement, secure with epoxy, and provide paving headers as required to provide rigid pavement sections.
      7) At joints, finish concrete surfaces adjacent to previously installed concrete to within plus 1/8-inch, with tooled radius of 1/4-inch.
   b. Expansion Joints:
      1) Properly position and stake in place load-transferring elements for expansion joints, consisting of dowels.
      2) Provide in each expansion joint expansion joint filler material and sealant, as shown and indicated in details on the Drawings.

3) Install expansion joint filler material in accordance with manufacturer's written instructions.
4) Following installation of filler material, thoroughly clean joint and install sealant in accordance with sealing manufacturer's written instructions. Upper surface of joint sealant shall be within 1/8-inch of finished surface of adjacent concrete pavement.
5) Remove excess sealant from joint and surfaces of adjacent pavement.

c. Construction Joints:
1) Provide construction joints at end of each day's work and where concrete placing is interrupted for 30 minutes or more.
2) Provide construction joints at open ends of concrete pavement.
3) Extend construction joint full width of pavement. Provide construction joint with same crown as crown required for concrete pavement.
4) Tooled joints:
a) Form groove in freshly placed concrete with tooling device.
b) Groove dimensions shall be 3/8-inch wide at surface, and 1/4-inch wide at root.
5) Sawcut Joints:
a) Sawcut groove, 1/4-inch wide, in recently placed concrete.
b) Commence sawcutting as soon as concrete is sufficiently hard to withstand sawcutting without chipping, spalling, tearing, or disturbance of aggregate, regardless of time of day and weather conditions.
c) Immediately prior to sawcutting, thoroughly wet surface of concrete to protect cured membrane. Immediately following sawcutting, apply membrane curing compound to sawcut area.
d) Complete sawcutting before shrinkage stresses result in cracking of concrete.

d. Isolation Joints:
1) Provide isolation joints where concrete paving abuts existing construction or facilities not part of the concrete paving, such as manhole cover frames, valve boxes, catch basins and other stormwater inlets, curbs, gutters, sidewalks, and other structures.
2) Provide in each isolation joint expansion joint filler material and sealant, in accordance with the Contract Documents, including details on the Drawings.
3) Install expansion joint filler material in accordance with manufacturer's written instruction.
4) Following installation of filler material, thoroughly clean joint and install sealant in accordance with sealing manufacturer's written instructions. Upper surface of joint sealant shall be within 1/8-inch of finished surface of adjacent concrete pavement.
5) Remove excess sealant from joint and surfaces of adjacent pavement.

e. Metal Keyway Joints:
1) Form by providing metal joint strip, to remain in place.
2) Stake and support in manner identical to side forms.
3) Provide dowels or tie bars, as required.

7. Placing Concrete:
a. Unless otherwise indicated in this Section, concrete placing shall comply with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing, including (but not limited to) requirements for hot weather and cold weather placing.
b. Advise Engineer in writing of scheduled date and time for commencement of concrete placing not less than 24 hours prior to commencing concrete placing.
c. Place concrete within 90 minutes after initial water was added. Remove and dispose of concrete not placed within such period.

d. Concrete slump during placing shall be in accordance with Article 2.3 of this Section unless traveling-form paver is used, in which case slump shall be not more than two inches.

e. Place concrete continuously in successive batches. Place concrete in manner necessitating the least extent of handling possible.

f. Where spreading by hand is necessary, install concrete using shovels, buckets, or other appropriate methods. Use concrete rakes for distributing concrete.

g. Provide transverse construction joints when concrete placing is interrupted for more than 30 minutes. When distance between construction joints would be 10 feet or less, remove concrete placed in such section so that spacing between construction joints is greater than 10 feet.

h. Carefully place concrete against forms and at longitudinal and transverse joints and prevent honeycombing. Voids at edges of finished concrete pavement will constitute defective Work.

i. Washout of Concrete Delivery Vehicles and Equipment:

1) Provide appropriate temporary facilities for washout (cleaning) of concrete delivery vehicles and equipment following discharge of concrete. Comply with Laws and Regulations.

2) Provide washout area not less than 50 feet from open stormwater conveyance routes including ditches and swales, catch basins and other stormwater inlets, wetlands and other sensitive wildlife habitats, surface waters, and water supply wells.

3) Provide washout areas conveniently accessible to concrete delivery vehicles and equipment in all weather conditions.

4) Provide multiple washout areas, or washout areas larger than required in this provision, when necessary for the Project, the Work being performed, and site and weather conditions.

5) Prefabricated units shall be not less than four feet by four feet by one foot deep with not less than four-mil polyethylene plastic liner. Constructed concrete washout areas shall be not less than six feet by six feet by three feet deep, with not less than 10-mil polyethylene liner, with side slopes of one foot vertical to two feet horizontal, and surrounded by one foot high by one foot wide berm of compacted fill material.

6) Liners shall be free of tears or holes and placed over smooth surfaces to prevent puncturing. For constructed washouts, anchor liners underneath berm, or over top of berm and held in place by sandbags or concrete blocks.

7) Provide temporary signage designating washout area and, for large construction sites, provide signage throughout the Site directing traffic to washout areas.

8) Allow washed out concrete mixture to harden through evaporation of contaminated wash water. When facility is 75 percent of capacity, remove hardened concrete by reusing broken aggregate onsite, recycling, or properly disposing offsite.

9) Provide new liners before reusing stations for additional washouts.

8. Consolidation of Concrete:

a. Unless otherwise indicated in this Section, consolidate concrete in accordance with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.

b. Consolidate concrete using appropriate mechanical vibrators. Extend vibratory unit across pavement perpendicular to intended traffic flow, and along entire longitudinal direction of concrete pavement.

c. Consolidate concrete pavement uniformly, with appropriate spacing of vibratory units. During consolidation, vibrators shall not contact forms, reinforcing, or pavement joints.

d. Furnish and use sufficient quantity of hand-manipulated mechanical vibrators for proper consolidation of concrete along forms, at joints and in areas not consolidated using mechanically controlled vibrators.

9. Finishing:

a. Unless otherwise indicated in this Section, concrete finishing shall comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
b. Finish concrete pavement with power-driven transverse finishing machines or by hand finishing. Regardless of finishing method used, maintain uniform ridge full width with first pass of first screed.
c. Transverse Finishing Machine:
    1) Furnish and use transverse finishing machine to perform not less than two passes over installed concrete pavement. Perform final pass in continuous run of not less than 40 feet.
    2) Strike off concrete with strike-off screed. Move strike-off screed forward with combined transverse and longitudinal motion in direction work is progressing, maintaining screed in contact with forms, and maintaining slight excess of materials in front of cutting edge.
    3) Perform floating in accordance with requirements, below.
d. Hand Finishing:
    1) Hand finish using mechanical strike-and-tamping template. Template shall extend across entire width of concrete pavement being finished. Shape template to pavement section required by the Contract Documents.
    2) Move strike template forward in direction of concrete placing, maintaining slight excess of material in front of template's cutting edge. Perform not less than two passes over each area.
    3) Screed pavement surface to required elevation and grade. Work screed with combined transverse and longitudinal motion in direction finishing Work is progressing. Maintain screed in contact with forms.
    4) Perform floating in accordance with requirements, below.
e. On narrow strips and transitions, finish concrete pavement by hand. Thoroughly work concrete around reinforcing and embedded items, such as manhole cover frames, valve boxes, catch basins, and similar items.
f. Floating - General:
    1) Tamp concrete with tamping template. Use longitudinal float to level concrete surface.
    2) Float by longitudinally reciprocating float, passing gradually from edge to edge.
    3) Ensure successive advances do not exceed half the length of the float.
    4) Test level of concrete with straightedge not less than 10 feet.
    5) Fill depressions with fresh concrete, consolidate, and refinish.
    6) Cut down high areas and retest.
    7) Tool pavement edges with suitable edger.
g. After completing screeding and floating, perform first pass of burlap drag before water sheen has disappeared from surface. Subsequently perform as many passes as necessary to provide required texture and amplitude. Time between passes shall be as short as practicable. Burlap drag material shall be maintained in wet, clean condition during dragging.
h. Retest concrete surface with straightedge and, if pavement is determined to deviate from Contract requirements by more than 1/8-inch in 10 feet, remedy the defective Work.

10. Curing:
    a. Unless otherwise indicated in this Section, concrete curing shall comply with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
    b. Provide membrane-forming curing compound in accordance with manufacturer's written instructions , at rate not less than 200 square feet per gallon.

c. Apply curing compound within four hours after finishing and as soon as moisture has dissipated from concrete surface.

d. Cure for not less than seven days.

e. When average daily ambient temperature is less than 50 degrees F, provide temporary insulation of not less than one foot thick loose dry straw, or equivalent, for 10 days. When straw is used for insulating, remove and properly dispose of straw at location other than the Site.

11. Concrete Surface Treatment:

a. After concrete paving has cured for 30 days, provide concrete surface treatment by providing concrete surface treatment material. Such material is specified in Article 2.3 of this Section.

b. Prior to applying surface treatment material, clean surface of concrete paving in accordance with surface treatment material manufacturer's written instructions.

c. Apply concrete surface treatment material to all new, repaired, and rehabilitated concrete pavement in accordance with AASHTO M224.

d. Quantity of Applications and Rates: Provide two separate applications of concrete surface treatment, at the following rates:

1) First application at rate of 67 square yards per gallon.

2) Second application to dry surface at rate of 40 square yards per gallon.

12. Protection of Concrete:

a. Refer to the "Protection" Article in this Section.

13. Opening to Traffic:

a. Refer to the "Protection" Article in this Section.

B. Installation Tolerances:

1. Milling: Tolerances for milling are indicated in the "Milling" provision of the "Preparation" Article of this Section.

2. Surface Trueness:

a. "Surface trueness", as used in this Section refers to new pavement constructed to required surface cross-section, with even surface, without abrupt changes or transitions in elevation or grade, and without ruts or raveling. Appropriately installed pavement results in no ponding of water and properly conveys stormwater runoff to appropriate drainage routes and stormwater inlets.

b. Engineer will evaluate surface trueness and compliance with surface tolerance by directing Contractor to provide 16-foot straightedge or string line placed parallel to centerline of pavement and with 10-foot straight edge or string line placed transversely to centerline of pavement. Variations exceeding tolerance indicated in the "Finishing" provision of this Article shall be corrected or pavement remedied and replaced at no additional cost to Owner.

c. Crowned Surfaces:

1) Test crowned surfaces with a crown template, centered and at right angles to the crown.

2) Surfaces will be acceptable when variance is equal to or less than 1/4-inch from the template.

3. Elevation: Finished surface of pavement shall be within plus or minus 1/2-inch of elevations shown or indicated. New pavement shall be equal in elevation to frames and covers of manholes, valve boxes and similar items, and allow appropriate stormwater drainage into stormwater inlets.

3.4 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

1. Engineer's Field Quality Control Activities:

a. Engineer may determine compliance with installation tolerances for locations of reinforcing steel and pavement joints, surface trueness, and depth and trueness of milling (where required), as indicated elsewhere in this Section. Contractor shall furnish implements required for evaluating and determining trueness of concrete pavement and milling.

b. Engineer may identify, by visual observation, areas of apparent defective concrete paving Work and appropriately advise or notify Contractor of such defects.

2. Responsibilities of Testing Laboratory:

a. field quality control testing laboratory will:

1) Test proposed materials for compliance with the Contract Documents, in accordance with this Article and the Specifications of Division 03 - Concrete.

2) When directed by Engineer, perform coring of installed concrete paving to determine compliance with required thickness and tolerances. Submit written results of tests to Engineer and Contractor.

b. Authority of Field Quality Control Testing Laboratory:

1) Technicians representing testing laboratory will inspect materials at the Site and perform required testing. When materials furnished or Work performed do not comply with the Contract Documents, field quality control testing laboratory technician shall promptly direct attention of Engineer and Contractor to such non-compliance.

2) Testing laboratory personnel shall not act as foreman or perform other duties for, or on behalf of, Contractor. The Work will be checked as it progresses, but failure to detect defective Work shall not in any way prevent later rejection of such defective Work when defect is discovered. Failure to detect defective Work as it occurs does not obligate Engineer to final acceptance. Testing laboratory personnel are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, nor to approve or accept any portion of the Work.

3. Concrete Testing – General:

a. Testing laboratory will test concrete for compressive strength, slump, water content, air content, and temperature in accordance with Section 03 05 05 - Concrete Testing and Inspection, unless otherwise indicated in this Section.

4. Compressive Strength Testing of Concrete:

a. Four specimens for compressive strength testing will be obtained in accordance with ASTM C31 for each 150 cubic yards and fraction thereof of concrete pavement placed in one day.

b. Two specimens will be tested at seven days. Remaining two specimens will be tested at 28 days.

c. Specimens will be tested in accordance with ASTM C39. Compression strength test results will be acceptable when:

1) Seven-day compressive strength: not less than 3,000 psi.

2) Twenty-eight-day compressive strength not less than compressive strength required in the “Mixes” provision of Article 2.3 of this Section.

d. When compression test indicates failure, yield test will be performed in accordance with ASTM C138 to determine cement content per cubic yard of concrete. If cement content is less than required, increase quantity of cement and SCM in subsequent batches until quantity of cement in concrete complies with requirements.

5. Flexural Strength Testing of Concrete:

a. When directed by Engineer or Owner’s Site Representative, testing laboratory technician will obtain additional samples in accordance with ASTM C31 for flexural strength testing, in accordance with ASTM C78.

6. Concrete Pavement Thickness:

a. Thickness of installed concrete will be determined by obtaining not less than one 4-inch diameter core at representative locations, determined by Engineer, for each 1,000 linear feet of traffic lane or 100 square yards of concrete pavement provided.
b. Depth shall be measured in accordance with ASTM C174/C174M. Each core may also be tested for 28-day compressive strength in accordance with ASTM C42.
c. Contractor may, at Contractor's cost, request three additional cores in vicinity of cores that resulted in deficient depth. For such additional locations, in-place depth shall be average depth of four cores.
d. Completely fill locations where cores were obtained with non-shrink grout, with surface elevation equal to surface of installed concrete.
e. Categories of Coring: In determining the average thickness of acceptable pavement for which payment will be made, the following core categories are established:

CATEGORY NUMBER	CORE THICKNESS IN RELATION TO REQUIRED THICKNESS	CORE DEPTH USED IN CALCULATING CHANGE IN COMPENSATION
1	1 inches or more deficiency	NOT USED
2	Less than 1 inch deficiency through 1/2 inches excess	Actual Core Thickness
3	More than 1/2 inches excess	Design Thickness plus 1/2 inches

f. Should measured thickness at any location be 0.5-inch or greater less than required thickness, two additional cores shall be obtained. First additional core shall be five feet from original core, parallel to direction of intended traffic flow. Second additional core shall be obtained five feet from original core and 180 degrees opposite first additional core.
g. If both additional cores indicate pavement thickness in accordance with the Contract Documents, within acceptable tolerances, further additional coring will not be performed for the subject zone of the Work.
h. If either, or both, additional cores are not within 0.5-inch of required pavement thickness, further cores shall be obtained in the following order on each side of the original (deficient) core parallel to intended direction of traffic flow:
   1) At intervals of 25 feet and 50 feet from the original (deficient) core, and thereafter at subsequent intervals of 50 feet from each successive core, until thickness deficiency of less than 0.5-inch is determined, in each direction from original (deficient) core.
   2) Contractor and Engineer may agree to perform additional coring to determine, more precisely, locations where pavement thickness becomes deficient by less than 0.5-inch. If Contractor and Engineer cannot so agree, then outermost of the further cores indicating thickness deficient by less than 0.5-inch will be considered as location where thickness was deficient by less than 0.5-inch.

7. Drainage:
   a. Upon completion and curing of concrete pavement provided under the Contract, Engineer will direct Contractor to spray clean water (whether potable or non-potable, and without observable solid material, biological matter, and Constituents of Concern) thoroughly over surface of concrete pavement, in presence of Engineer , or Owner's Site Representative.
   b. Spray sufficient quantity of water over concrete pavement to result in visually obvious runoff to drainage routes.
   c. In lieu of water spray, Naturally occurring precipitation sufficient for visually observable runoff is acceptable.

d. Immediately following conclusion of spraying or precipitation event, as applicable, Engineer , or Owner's Site Representative will mark areas of ponding, if any, with appropriate lumber crayon of high visibility color contrasting with pavement. Contractor shall furnish necessary quantity of lumber crayons. Immediately following marking, obtain digital photographic documentation of each marked area..

e. Engineer or Owner may redesignate, re-mark, or both, areas of ponding as such areas become apparent to Engineer or Owner.

8. Surface Trueness:

a. Contractor's obligations regarding assisting Engineer in determining compliance with milling tolerances are indicated in the "Milling" provision of Article 3.2 of this Section.

b. Contractor's obligations regarding assisting Engineer in determining compliance with tolerance for trueness of installed concrete pavement are indicated in the "Installation Tolerances" provision of Article 3.3 of this Section.

B. Defective Paving Work:

1. The following constitutes defective concrete paving Work: ruts, ridges, roller marks, cracking, tearing, segregation, ponding of stormwater, or other irregularities. Concrete paving Work that does not comply with required tolerances or other requirements of the Contract Documents, or that is damaged while protection is Contractor's responsibility, will be considered as defective Work.

2. When directed by Engineer, remove and replace defective concrete paving Work. Cut out full depth of such areas of defective pavement and fill with new reinforced concrete. When pavement is cut out or removed for such remedies, the area removed shall be of regular shape with right angles. To extent practicable, cut-out areas shall be square or rectangular. Surface of repaired areas shall be flush with adjacent pavement.

3. Remove and replace areas of pavement thinner than required thickness by more than 0.5-inch, or that fail either compressive strength tests or flexural strength tests, with concrete of required thickness and quality.

4. Nonconforming pavement sections shall be replaced at no additional cost to Owner.

3.5 CLEANING

A. Cleaning: After completing concrete paving installation, completely clean surfaces of excess and spilled materials, excess concrete, and foreign matter. Appropriately dispose of such material.

3.6 PROTECTION

A. Protection of Installed Concrete Paving:

1. Do not drive equipment, machinery, or vehicles on concrete unless such equipment, machinery, or vehicle (as applicable), is rubber-tired and only when concrete is designed for, and capable of, sustaining associated loading. Do not drive over new or existing concrete with tracked vehicles or equipment.

2. Protect concrete surfaces and appurtenances from traffic for not less than 14 days after concrete placing and finishing.

3. Protect finished pavement until pavement is opened for non-construction traffic.

4. Cover openings of drainage structures, manholes, valve boxes, and similar items in paved areas until permanent coverings are provided.

5. Remedy concrete surfaces damaged by traffic, or other causes, occurring prior to Substantial Completion.

6. Maintain concrete paving in good condition until Substantial Completion.

7. When pavement markings are a part of the Work, comply with requirements for protecting pavement markings in the "Application of Pavement Markings" Article of this Section.

B. Opening Pavement to Traffic:

1. On those sections of pavement to be opened to traffic, seal joints, clean pavement, and place earth against pavement edges (when pavement edges are not otherwise protected or abutted by gutters, curbing, or shoulders) before opening to traffic. Such opening of pavement to traffic shall not relieve Contractor from responsibility for the Work.
2. After 14 days following concrete placing and finishing, pavement may, at Engineer's discretion (who may elect to consult with Owner), be opened to traffic when the Project's cured concrete test cylinders have attained compressive strength of not less than 3,000 psi.

END OF SECTION

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SECTION 32 16 23
CONCRETE SIDEWALK AND STEPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete sidewalk and steps.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 31 30 - Concrete, Materials and Proportioning.
2. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
3. Section 03 05 05 - Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M153, Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   b. M171, Sheet Materials for Curing Concrete.
   c. M182, Burlap Cloth Made from Jute or Kenaf.
   d. M213, Preformed Expansion Joint Fillers for Concrete Paving and Structure Construction (Nonextruding and Resilient Bituminous Types).
   e. M224, Use of Protective Sealers for Portland Cement Concrete.
   f. M233, Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
2. American Concrete Institute (ACI):
   a. 305R, Hot Weather Concreting.
   b. 306R, Cold Weather Concreting.
3. ASTM International (ASTM):
   a. A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   b. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   d. C33, Standard Specification for Concrete Aggregates.
   e. C150, Standard Specification for Portland Cement.
   f. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   g. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 feet-LBF/FT^3).
   h. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   i. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
4. Federal Specification (FS):
   a. SS-S-1614, Sealants, Joint, Jet-Fuel-Resistant, Hot-Applied for Portland Cement and Tar Concrete Pavements.
   b. TT-S 00227 E(3), Sealing Compound: Elastomeric Type, Multi-Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
2. Mix design(s) in accordance with Specification Section 03 31 30 and Specification Section 03 05 05.
3. Qualifications of concrete installer.
4. Drawings detailing all reinforcing.
5. Concrete cylinder test results from field quality control.

B. Samples:

1. Samples of fabricated jointing materials and devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Chemical admixtures:
   a. Sika Chemical Corporation.
   b. Master Builders Solutions.
   c. Protex Industries.
   d. W. R. Grace and Company.

2.2 MATERIALS

A. Portland Cement:

1. ASTM C150, Type I or II.

B. Aggregates:

1. ASTM C33, gradation size #67, 3/4 inches to #4.

C. Water:

1. Potable quality.

D. Admixtures:

1. Comply with Specification Section 03 31 30.

E. Reinforcing Bars:

1. ASTM A615, Grade 60.

F. Welded Wire Reinforcement:

1. ASTM A185 or ASTM A1064.
2. Flat.
3. Clean, free from dirt, scale, rust.

G. Preformed Joint Filler:

1. Nonextruding cork, self-expanding cork, sponge rubber or cork rubber.
2. Meet AASHTO M153 or AASHTO M213.

H. Hot-Poured Joint Sealing Material:

1. FS SS-S-1614.

I. Sidewalk Joint Sealant:

1. Two compound, polyurethane sealant.
2. Class A, Type 1.
3. Self-leveling.
4. Nontracking.
5. FS TT-S 00227 E(3).

J. Membrane Curing Compound:

1. ASTM C309.

K. Cover Materials for Curing:

1. Burlap:
   a. AASHTO M182.
   b. Minimum Class 2, 8 oz material (1 yard x 42 inches).
2. Polyethylene film:
   a. AASHTO M171.

L. Paper Subgrade Cover:

1. Polyethylene film, AASHTO M171.

M. Concrete Treatment:

1. Boiled linseed oil mixture.
2. Meets AASHTO M233.

N. Forms:

1. Steel or wood.
2. Size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment.
3. Free of distortion and defects.
4. Full depth.
5. Metal Side Forms:
   a. Minimum 7/32 inches thick.
   b. Depth equal to edge thickness of concrete.
   c. Flat or rounded top minimum 1-3/4 inches wide.
   d. Base 8 inches wide or equal to height, whichever is less.
   e. Maximum deflection 1/8 inches under center load of 1700 pounds.
   f. Use flexible spring steel forms or laminated boards to form radius bends.

2.3 MIXES

A. Mix design to provide 4,000 psi 28-day compressive strength, 1-1/2 inches +1 inches slump, 6% air.

B. Comply with Specification Section 03 31 30 and Specification Section 03 31 31.

PART 3 - EXECUTION

3.1 PREPARATION

A. Subgrade Preparation:

1. Prepare using methods, procedures, and equipment necessary to attain required compaction densities, elevation and section.
2. Scarify and recompact top 6 inches of fills and embankments which will be sidewalk and step areas.
3. Remove soft or spongy areas.

a. Replace with aggregate material.

4. Compact to the following densities:
   a. Cohesive soils: 95% per ASTM D698.
   b. Noncohesive soils: 75% relative per ASTM D4253 and ASTM D4254.
5. Assure moisture content is within limits prescribed to achieve required compaction density.
6. Following compaction, trim and roll to exact cross section.
   a. Check with approved grading template.
7. Perform density tests on subgrade to determine that subgrade complies with the specification.

B. Aggregate Course:

1. Place material in not more than 6 inches thick layers.
2. Spread, shape, and compact all material deposited on the subgrade during the same day.
3. Compact to 75% relative per ASTM D4253 and ASTM D4254.

C. Loose and Foreign Material:

1. Remove loose and foreign material immediately before application of paving.

D. Appurtenance Preparation:

1. Block out or box out curb inlets and curb returns.
2. Provide for joint construction as detailed and dimensioned on Drawings.
3. Adjust manholes, inlets, valve boxes and any other utility appurtenances to design grade.
   a. Secure to elevation with concrete.
   b. Place concrete up to 5 inches below design grade.
4. Clean and oil forms.

3.2 ERECTION, INSTALLATION AND APPLICATION

A. Concrete Production:

1. Comply with Specification Section 03 31 31.

B. Forms:

1. Form support:
   a. Compact soil foundation and cut to grade to support forms.
   b. Use bearing stakes driven flush with bottom of form to supplement support as necessary.
   c. Do not use earth pedestals.
2. Staking forms:
   a. Joint forms neatly and tightly.
   b. Stake and pin securely with at least three pins for each 10 feet section.
3. Clean and oil forms prior to placement of concrete.
4. Set forms sufficiently in advance of work (minimum 2 hours) to permit proper inspection.
5. Previously finished pavement or curb and gutter contiguous with new work may serve as side form when specifically approved.

C. Reinforcing:

1. Lap mats one full space.
2. Tie end transverse member of upper mat securely to prevent curling.
3. Lap nonwelded bars 12 inches minimum.
4. Support:
   a. Place bars securely on chairs at called-for height.

b. Place other fabric on the first of a two-course pour and cover promptly with final pour, or place fabric by a fabric-placer if procedure is reviewed and approved by Engineer.

D. Joints:

1. Hold locations and alignment to within + 1/4 inches.
2. Finish concrete surface adjacent to previous section to within + 1/8 inches, with tooled radius of 1/4 inches.
3. Metal keyway joints:
   a. Form by installing metal joint strip, left in place.
   b. Stake and support like side form.
   c. Provide dowels or tie bars.
4. Weakened plane joints:
   a. Locate at 6 feet intervals.
   b. Tool groove in freshly placed concrete with tooling device.
   c. Groove dimensions shall be 3/8 inches at surface and 1/4 inches at root.
5. Install construction joints at end of day's work or wherever concreting must be interrupted for 30 minutes or more.
6. Expansion joints:
   a. Locate at 48 feet intervals and at all intersection curb returns.
   b. Stake in place load transfer device consisting of dowels.
   c. Supporting and spacing means and premolded joint filler as per Drawing details.
   d. Provide preformed joint filler at all junctions with existing sidewalks, steps, or other structures.
7. Thoroughly clean and fill joints with joint sealing material as specified.
8. Upper surface of filled joint to be flush to 1/8 inches below finish surface.

E. Place Concrete:

1. Comply with Specification Section 03 31 31.
2. Construct driveway openings and other features as per Drawing details.

F. Cold and Hot Weather Concreting:

1. Cold weather:
   a. Cease concrete placing when descending air temperature in shade falls below 40 degrees F.
   b. Do not resume until ambient temperature has risen to 40 degrees F.
   c. If placing is authorized below 40 degrees F by Engineer, maintain temperature of mix between 60 and 80 degrees F.
   d. Heat aggregates or water or both.
   e. Water temperature may not exceed 175 degrees F.
   f. Aggregate temperature may not exceed 150 degrees F.
   g. Remove and replace frost damaged concrete.
   h. Salt or other antifreeze is not permitted.
   i. Comply with ACI 306R.
2. Hot weather:
   a. Cease concrete placing when plastic mix temperature cannot be maintained under 90 degrees F.
   b. Aggregates or water or both may be cooled.
   c. Cool water with crushed ice.
   d. Cool aggregates by evaporation or water spray.

e. Never batch cement hotter than 160 degrees F.

f. Comply with ACI 305R.

G. Finishing:

1. As soon as placed, strike off and screed to crown and cross section, slightly above grade, so that consolidation and finishing will bring to final Drawing elevations.
2. Maintain uniform ridge full width with first pass of first screed.
3. Test with 6 feet straightedges equipped with long handles and operated from sidewalk.
4. Draw excess water and laitance off from surface.
5. Float finish so as to leave no disfiguring marks but to produce a uniform granular or sandy texture.
6. Broom finish after floating.
7. Tool edges with suitable edger.
8. Provide exposed aggregate surfaces in areas indicated on the Drawings.
9. Provide method such as abrasive blasting, bush hammering, or surface retarder acceptable to the Engineer.

H. Curing:

1. Apply membrane curing compound complying with ASTM C309, and in accordance with manufacturer's directions but at a rate of minimum 200 square feet per gallon.
2. Apply curing compound within 4 hours after finishing or as soon as surface moisture has dissipated.
3. Cure for minimum of seven days.
4. When average daily temperature is below 50 degrees F, provide insulative protection of 12 inches minimum thickness loose dry straw, or equivalent, for 10 days.
5. Linseed oil sealant:
   a. For concrete sidewalk and step, seal surface with linseed oil.
   b. Apply linseed oil to clean surface as per AASHTO M224 after concrete has cured for 1 month.
   c. Apply first application at rate of 67 square yards per gallon.
   d. Apply second application to a dry surface at rate of 40 square yards per gallon.

I. Protection of Concrete:

1. Protect new sidewalk, steps, and their appurtenances from traffic for a minimum of 14 days.
2. Repair or replace parts of sidewalk and steps damaged by traffic, or other causes, prior to final acceptance.

J. Opening to Traffic:

1. After 14 days, area may, at Owner's discretion, be opened to traffic if job cured cylinders have attained a compressive strength of 3000 pounds per square inch when tested in accordance with ASTM standard methods.
2. Prior to opening to traffic, clean and refill joints as required with specified filler material.

K. Clean Up:

1. Assure clean-up work is completed within two weeks after sidewalk has been opened to traffic.
2. No new work will begin until clean-up work has been completed, or is maintained within 2 weeks after sidewalk has been opened to traffic.

L. Handrails:

1. Provide handrails where required and as per Drawing details.

3.3 FIELD QUALITY CONTROL

A. Provide test cylinders in accordance with Specification Section 03 05 05 for each placement

END OF SECTION

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SECTION 32 31 13
CHAIN LINK FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain link fencing and gates.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 03 31 30 - Concrete.
2. Section 31 23 05 - Excavation and Fill.
3. Section 31 23 33 - Trenching and Backfilling.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   c. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence.
   d. F552, Standard Terminology Relating to Chain Link Fencing.
   e. F567, Standard Practice for Installation of Chain-Link Fence.
   f. F626, Standard Specification for Fence Fittings.
   g. F900, Standard Specification for Industrial and Commercial Steel Swing Gates.
   h. F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
   i. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
2. American Welding Society (AWS).
3. National Fire Protection Association (NFPA):
   a. NFPA 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL).

B. Qualifications:

1. Installer bonded and licensed in the Project state.
2. Installer shall have a minimum two years experience installing similar fencing.
3. Utilize only AWS certified welders.
4. Electric gate operators to be UL listed.
5. Grounding by an electrician licensed in Project state.

1.3 DEFINITIONS

A. See ASTM F552.

B. NPS: Nominal pipe size, in inches.

C. Installer or Applicator:

1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
2. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
3. Mill certificates.
4. Source quality control test results.
5. Automatic gate system:
   a. Electrical circuitry and control wiring.
   b. Intercom system.
   c. Detector loop layout.
   d. Locking plan.
   e. Method of installation of detector loop.
   f. Sealant material for detector loops.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Chain Link Fabric:

1. Fabric type:
   a. ASTM A116 zinc-coated steel:
      1) Coated before weaving, 1. 2 oz/SQFT.
2. Wire gage: 11.
3. Mesh size: 2 inches.
4. Selvage treatment:
   a. Top: Knuckled.
   b. Bottom: Knuckled.

B. Concrete: See Specification Section 03 31 30 - Concrete.

C. Line Post:

1. ASTM F1083 pipe:
   a. Schedule 40, NPS 2.

D. Corner or Terminal Posts:

1. ASTM F1083 pipe:
   a. Schedule 40, NPS 2-1/2.

E. Brace and Rails:

1. ASTM F1083 pipe:
   a. Schedule 40, NPS 1-1/4.

F. Tension Wire:

1. Top and bottom of fabric:
   a. ASTM A824, galvanized steel, Class 3.

G. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):

1. ASTM F626.

H. Swing Gate:

1. ASTM F900.
2. Materials as specified for fence framework and fabric.
3. Hardware:
   a. Galvanized per ASTM A153/A153M.
   b. Hinges to permit 180 degrees outward gate opening.

2.2 SOURCE QUALITY CONTROL

A. Test related fence construction materials to meet the following standards:

1. Posts and rails: ASTM F1043, Heavy Industrial.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with:

1. Manufacturer's instructions.
2. Lines and grades shown on Drawings.
3. ASTM F567.

B. Do not start fence installation before final grading is complete and finish elevations are established.

C. Drill holes in firm, undisturbed or compacted soil.

D. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Drawings.

1. Correct minor irregularities in earth to maintain maximum clearance.

E. Space line posts at equal intervals not exceeding 10 feet on-center.

F. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.

G. Install tension bars full height of fabric.

H. Rails:

1. Fit rails with expansion couplings of outside sleeve type.
2. Rails continuous for outside sleeve type for full length of fence.

I. Provide expansion couplings in top rails at not more than 20 feet intervals.

J. Anchor top rails to main posts with appropriate wrought or malleable fittings.

K. Install bracing assemblies at all end and gate posts, as well as side, corner, and pull posts.

1. Locate compression members at mid-height of fabric.
2. Extend diagonal tension members from compression members to bases of posts.
3. Install so that posts are plumb when under correct tension.

L. Pull fabric taut and secure to posts and rails.

1. Secure so that fabric remains in tension after pulling force is released.
2. Secure to posts at not over 15 inches on-center, and to rails at not over 24 inches on-center, and to tension wire at not over 24 inches on-center.

3. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
4. Bend ends of wire to minimize hazards to persons or clothing.

M. Install post top at each post.

N. Gates:

1. Construct with fittings or by welding.
2. Provide rigid, weatherproof joints.
3. Assure right, non-sagging, non-twisting gate.
4. Coat welds with rust preventive paint, color to match pipe.

O. Install electric gate operator in accordance with NFPA 70.

END OF SECTION

DIVISION 40

PROCESS INTERCONNECTIONS

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SECTION 40 05 00
PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Process piping systems.
2. Utility piping systems.
3. Plumbing piping systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 09 96 00 - High Performance Industrial Coatings.
2. Section 40 05 07 - Pipe Support Systems.
3. Section 40 05 51 - Common Requirements for Process and Utility Valves.
4. Section 40 73 00 - Pressure Instrumentation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings.
   b. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
   c. B40.100, Pressure Gauges and Gauge Attachments.
2. ASTM International (ASTM):
   a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. American Water Works Association (AWWA):
   a. C200, Standard for Steel Water Pipe - 6 inches and Larger.
   b. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.
   c. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   d. C210, Liquid Epoxy Coatings and Linings for Steel Pipe and Fittings.
   e. C606, Standard for Grooved and Shouldered Joints.
4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.

B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Test reports:

a. Copies of pressure test results on all piping systems.

b. Notification of time and date of piping pressure tests.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe coating during handling using methods recommended by manufacturer.

1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

B. Prevent damage to pipe during transit.

1. Repair abrasions, scars, and blemishes.

2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Pipe saddles (for gage installation):

a. Dresser Style 91 (steel and ductile iron systems).

b. Dresser Style 194 (nonmetallic systems).

2. Dismantling Joint

a. Romac DJ400.

b. Smith Blair 972.

2.2 PIPING SYSTEMS SCHEDULE

A. Piping system materials, fittings and appurtenances are subject to requirements of specific piping systems schedule located at the end of PART 3 of this Specification Section.

2.3 COMPONENTS AND ACCESSORIES

A. Reducers:

1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.

2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

B. Protective Coating and Lining:

1. Include pipe, fittings, and appurtenances where coatings, linings, coating, tests and other items are specified.

C. Pressure Gages:

1. See Specification Section 01 61 03 and Specification Section 40 73 00.

D. Valves:

1. See Specification Section 40 05 51.

PART 3 - EXECUTION

3.1 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 inches may not be shown; however, install according to Drawing intent and with clearance and allowance for:

1. Expansion and contraction.
2. Operation and access to equipment, doors, windows, hoists, moving equipment.
3. Headroom and walking space for working areas and aisles.
4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 29 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support:

1. Use methods of piping support as shown on Drawings and as required in Specification Section 40 05 07.
2. Piping support systems for piping 12 inches and greater are shown on the Drawings.
   a. Support systems for piping smaller than 12 inches diameter are not shown on the Drawings.
   b. Contractor is responsible for design of these support systems per Specification Section 40 05 07.
3. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Equipment Drainage and Miscellaneous Piping:

1. Provide drip pans and piping at equipment where condensation may occur.
2. Avoid piping over electrical components such as motor control centers, panelboards, etc.
   a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
   b. Hard pipe drainage to nearest floor drain.
3. Collect system condensate at drip pockets, traps and blowoff valves.
4. Provide drainage for process piping at locations shown on Drawings in accordance with Drawing details.

G. Unions:

1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
2. Mechanical type couplings may serve as unions.
3. Additional flange unions are not required at flanged connections.

H. Install expansion devices as necessary to allow expansion/contraction movement.

I. Provide full face gaskets on all systems.

J. Anchorage and Blocking:

1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

K. Equipment Pipe Connections:

1. Equipment - General:
   a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
   b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.

c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
    1) Provide tightening torque in accordance with manufacturer's recommendations.
d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
g. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
    1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
    2) Realign as necessary, install flange bolts and make equipment connection.
i. Provide utility connections to equipment shown on Drawings, scheduled or specified.

L. Provide insulating components where dissimilar metals are joined together.

M. Instrument Connections:

1. See drawing details.

3.2 CONNECTIONS WITH EXISTING PIPING

A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.

B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.

C. Undertake connections in fashion which will disturb system as little as possible.

D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.

E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.

F. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.3 PRESSURE GAGES

A. Provide at locations shown on the Drawings and specified.

B. See Specification Section 01 61 03.

3.4 FIELD QUALITY CONTROL

A. Pipe Testing - General:

1. Test the high-lift and low-lift piping systems as follows:
    a. Visually inspect for leaks during startup when system is at operating pressure; repair any and all leaks to a zero-leakage condition.
2. Verify the oil-lube system and the air compressor piping systems have zero-leakage; repair any and all leaks to zero-leakage condition.

3.5 CLEANING, DISINFECTION AND PURGING

A. Cleaning:

1. Clean interior of piping systems thoroughly before installing.

2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
    a. Pig high pressure air piping before connecting to valves or instruments.
4. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
    a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
    b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.

3.6 LOCATION OF BURIED OBSTACLES

A. Furnish exact location and description of buried utilities encountered and thrust block placement.

B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.

C. Include such information as location, elevation, coverage, supports and additional pertinent information.

D. Incorporate information on "As-Recorded" Drawings.

3.7 PIPING SYSTEM SCHEDULES

A. High-Lift and Low-Lift Piping – Exposed, Steel, Process Piping Operating Under Pressure at up to 100 psiG.

1. General:
    a. Piping symbol and service:
        1) CA – Compressed Air
        2) LUB – Lubrication Oil
        3) PIRR – Pressure Irrigation
        4) D – Drain
2. System components:
    a. Pipe size 18 and 20 inches:
        1) Exposed service:
            a) Material:
                (1) Flanged: A53B, SCH10 Black pipe steel, 0.25-inch wall thickness.
                (2) Grooved type joint system: Use pipe thickness per AWWA C606.
            b) Reference: AWWA/ANSI C200.
            c) Lining: High solids polyamine-epoxy, two-part coal tar epoxy per AWWA C210, or hot-dipped galvanized.
            d) Coating: High solids polyamine-epoxy, Two-part marine-grade epoxy per AWWA C210, hot-dipped galvanized or fusion bonded epoxy.
            e) Fittings: Welded steel
            f) Joints:
                (1) Flanged (AWWA C207, Class D, ANSI B16.5 class 150) joints.
                (2) Bolted Sleeve-Type Couplings for Plain End, AWWA C219-23
                (3) With both systems, provide screwed-on flanges at equipment, valves and structure penetrations.

B. Air Compressor Piping System 11 – Exposed Piping for Plant Compressed Air and Instrument Air Service up to 100 psiG.

1. General:
   a. Piping symbol and service:
      1) CA - Compressed Air.
   b. Test requirements:
      1) Test medium: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
      2) Pressure: 150 psiG.
      3) Duration: 6 hours.
   c. Gaskets and O-rings:
      1) O-ring and flanged joints: Rubber or neoprene, 250 degrees F.
      2) Grooved coupling joints (steel): AWWA C606, rubber, 250 degrees F.
2. System components:
   a. Pipe size to 1 inch for CA:
      1) Exposed service:
         a) Material: Stainless steel TP-304L, aluminum, copper.
         b) Reference: ASTM A269.
         c) Lining: None.
         d) Coating: None.
         e) Fittings: Stainless steel 304L, nylon fittings for aluminum tubing, or copper.
         f) Joints: Compression type couplings, unions at equipment and valves.
3. Slope all piping mains approximately 1:100 toward points of drainage.
4. Provide driplegs at low points:
   a. Provide ball type isolation valve.
   b. Route dripleg to nearest wall or column and terminate 4 feet above finished floor.

C. Piping System 21 –Exposed Building Condensate Drain.

1. General:
   a. Piping symbol and service:
      1) CD – HVAC Condensate Drain.
   b. Test requirements:
      1) Test medium: Water.
      2) Pressure: See the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
      3) Duration: 6 hours.
   c. Gaskets: Rubber, ASTM C564.
2. System components:
   a. Pipe size 1-1/2 inches and smaller:
      1) Exposed service.
         a) Material: Galvanized steel, Schedule 40.
         b) Reference: ASTM A53.
         c) Lining: Galvanized.
         d) Coating: HPIC; See Specification Section 09 96 00.
         e) Fittings: Cast iron drainage.
            (1) ASTM A126, Class B.
         f) Joints: Threaded.

3.8 SERVICE SYSTEM SUMMARY

A. Service Systems as defined in the Drawings.

END OF SECTION

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SECTION 40 05 07
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe anchor system for the 18” and 20” pipes in the valve vault.

1.2 QUALITY ASSURANCE

A. Responsibility:

1. Support systems for piping greater than 12 inches diameter, or with internal pressure over 100 psi, or piping with product temperatures over 200 degrees F, are shown on the Drawings and are not to be designed by Contractor unless indicated in Contract Documents.
2. Design complete support systems for piping 12 inches and smaller where supports are not shown on the Drawings.
3. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.
4. Incorporate those details with requirements of this Specification Section to provide the piping support system.

B. Each type of pipe hanger or support shall be the product of one manufacturer.

PART 2 - EXECUTION

2.1 INSTALLATION

A. Provide a fabricated steel support with suitable pipe strap to mitigate pipe movement in the valve vault.

1. Included in this requirement for each of the six pipe supports in the valve vault are:
   a. Base plate shall be ¼” epoxy coated steel base plate
   b. Anchor bolt base plate to concrete floor,

END OF SECTION

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SECTION 40 05 24
PIPE - STEEL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel pipe, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:

1. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
   b. B1.2, Gages and Gaging for Unified Inch Screw Threads.
   c. B16.3, Malleable Iron Threaded Fittings.
   d. B16.5, Pipe Flanges and Flanged Fittings.
   e. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
   f. B16.11, Forged Steel Fittings, Socket Welding and Threaded.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   d. A181, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   e. A276, Standard Specification for Stainless Steel Bars and Shapes.
3. American Water Works Association (AWWA):
   a. C200, Standard for Steel Water Pipe - 6 inches and Larger.
   b. C203, Standard for Coal-Tar Protective Coatings and Linings for Steel water Pipeline - Enamel and Tape - Hot Applied.
   c. C206, Standard for Field Welding of Steel Water Pipe.
   d. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.
   e. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   g. C213, Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   h. C606, Standard for Grooved and Shouldered Joints.
   i. M11, Steel Pipe - A Guide for Design and Installation.

B. Qualifications:

1. Application of coating materials including preparation of surfaces, priming, and lining and coating of pipe, fittings, and specials, in shop, repairs of any damage to lining or coating occurring during shipment or any other time, and field lining and coating of ends where linings or coatings have been held back for welded field joints, shall be done by established and recognized pipe company acceptable to Engineer.

2. Use only certified welders meeting procedures and performance outlined in ASME Section IX, AWWA C200 Section 3.3.3 and other codes and requirements per local building and utility requirements.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 05 00.
2. Factory test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Flanged adaptors:
   a. Rockwell (Style 913 (steel)).
   b. Dresser (Style 128 (steel)).
   c. Romac
2. Reducing couplings:
   a. Rockwell (Style 415).
   b. Dresser (Style 62).

2.2 MATERIALS

A. All materials used in steel piping systems defined in Section 40 05 00 shall meet or exceed pressure test requirements specified for each respective system.

B. Steel Pipe (Fabricated Type):

1. AWWA C200:
   a. ASTM A36, Grade C steel plate.
   b. ASTM A283, Grade D steel plate.
   c. ASTM A572, steel plate.
   d. ASTM A1011, steel sheet.

C. Steel Pipe (Mill Type): ASTM A53, Type E or S.

A. Fittings (For Fabricated Pipe): AWWA C208.

B. Fittings (For Mill Type Pipe):

1. ASTM A234.
2. ASME B16.3, ASME B16.5, ASME B16.9, ASME B16.11.

C. Flanges (Fabricated Pipe):

1. Type: AWWA C207
2. Flange material: ASTM A283, Grade C or D, ASTM A181, Grade 1.
3. Flange finish: Flat faced.
4. Pressure rating: greater than or equal to pipe test pressure

D. Flanges (Mill Type Pipe):

1. ASME B16.5.
2. Flat faced.
3. Slip-on flanges.

E. Nuts and Bolts:

1. Buried:
    a. Bolts and nuts: ASTM A307 ASTM A193/A194 Grade B8 Class 1.
    b. Wax Tape Coatings per AWWA C217
2. Exposed: Mechanical galvanized ASTM B695, Class 40 ASTM A193/A194 Grade B8 Class 1.
3. Heads and dimensions per ASME B1.1.
4. Threaded per ASME B1.1.
5. Project ends 1/4 to 1/2 inches beyond nuts.

F. Gaskets: See individual piping systems in Section 40 05 00.

2.3 MANUFACTURED UNITS

A. Couplings:
1. Flanged adaptors:
    a. Steel or carbon steel body sleeve, flange, followers and Grade 30 rubber gaskets.
    b. Provide units specified in Article 2.1.
    c. Flanges meeting standards of adjoining flanges.
    d. Tie bolt assembly.
        1) For pipe 14 inches and larger.
        2) Minimum four (4) bolts equally spaced around the pipe and extending from cast steel lugs welded on the pipe to lugs welded on the coupling middle ring.
    e. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
2. Compression sleeve coupling:
    a. Steel sleeve, followers Grade 30 and rubber gaskets.
    b. Provide units specified in Article 2.1.
    c. Flanges meeting standards of adjoining flanges.
    d. Tie bolt assembly.
        1) For pipe 14 inches and larger.
        2) Minimum four (4) bolts equally spaced around the pipe and extending from cast steel lugs welded on the pipe to lugs welded on the coupling middle ring.
    e. Entire assembly to be rated for test pressure specified on Piping Schedule for each respective application.
    f. Provide field coating for buried couplings per AWWA C203.
3. Mechanical coupling joint:
    a. Use of mechanical grooved (AWWA C606) type couplings and fittings in lieu of flanged joints is acceptable where specifically specified in Section 40 05 00.
    b. Utilize units defined in Article 2.1.

2.4 FABRICATION

A. Provide piping (mill or fabricated) for use in this Project with minimum wall thicknesses as follows:
1. 1/8 - 5 inches diameter pipe: Schedule 40.
2. 6 - 10 inches diameter pipe: 3/16 inches.
3. 12 - 14 inches diameter pipe: 7/32 inches.
4. 16 - 48 inches diameter pipe: 1/4 inches.
5. 54 - 60 inches diameter pipe: 5/16 inches.
6. 66 - 72 inches diameter pipe: 3/8 inches.
7. Sizes through 24 inches are nominal OD.

a. Sizes greater than 24 are ID.

8. Wall thicknesses indicated are for standard weight pipe.

a. Design pipe in accordance with operating pressures shown in Piping Schedules for a design stress limited to 50% of yield.

B. Furnish cast parts with lacquer finish compatible with finish coating.

C. Furnish without outside coating of bituminous material any exposed pipe scheduled to be painted.

D. Fabricated Fittings:

1. AWWA C208.
2. Assure ratio of radius of bend to diameter of pipe equal to or greater than 1.0.

E. Taper cement mortar linings as required for valve interfacing.

F. Protective Coatings and Linings:

G. Pipe Coatings:

1. Primer and prefabricated cold-applied tape in accordance with AWWA C209.
2. Epoxy in accordance with AWWA C210.
3. Fusion-bonded epoxy in accordance with AWWA C213.
4. Cold applied type in accordance with AWWA C214.
5. Galvanizing in accordance with ASTM B6.
6. 3M "Scotchkote" or Energy Coatings Company "Encoat" in accordance with manufacturer's recommendations.
7. Provide enamel linings and coatings in accordance with AWWA C203 and the following:

a. Nonpotable fluids: Provide minimum dry film of 5 mils of acceptable asphalt base material.

b. Provide coating in accordance with AWWA C203 and subject to following additional requirements.

1) Do not use enamel lined or coated steel pipe exposed to temperatures below 10 DEGF.

2) Do not handle enamel-lined or coated pipe when temperature of pipe is below 20 DEGF.

3) Coal Tar: Provide coal tar enamel having penetration of 15 to 20 at a temperature of 77 degrees F.

8. Galvanize surface in accordance with hot-dip method using any grade of zinc acceptable to ASTM B6.
9. Wrap pipe in accordance with AWWA C209.
10. Field paint pipe in accordance with Section 09 96 00.

2.5 SOURCE QUALITY CONTROL

A. Testing:

1. Shop hydrostatic test fabricated steel pipe and fittings.
2. Field hydrostatic test all pipe as specified in Section 40 05 00.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Joining Methods - Flanges:

1. Facing method:

a. Insert slip-on flange on pipe.
b. Assure maximum tolerances for flange faces from normal with respect to axis of pipe is 0.005 inches per foot of flange diameter.
c. Test flanges after welding to pipe for true to face condition and reface, if necessary, to bring to specified tolerance.

2. Joining method:
   a. Leave 1/8 to 3/8 inches of flange bolts projecting beyond face of nut after tightening.
   b. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems.
   c. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings.
      1) Allow one flange free movement in any direction while bolts are being tightened.
   d. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened.
   e. Gradually tighten flange bolts uniformly to permit even gasket compression.
   f. Do not overstress bolts to compensate for poor installation.

C. Joining Method - Welded Joints:
1. Perform welding in accordance with AWWA C206 and this Section.
2. For flange attachment perform in accordance with AWWA C207.
3. Have each welding operator affix an assigned symbol to all his welds.
   a. Mark each longitudinal joint at the extent of each operator's welding.
   b. Mark each circumferential joint, nozzle, or other weld into places 180 degrees apart.
4. Welding for all process piping shall conform to ASME B31.3.
   a. Welding of utility piping 125 psi and less shall be welded per ASME B31.9.
   b. Utility piping above 125 psi shall conform to ASME B31.1.
5. Provide caps, tees, elbows, reducers, etc., manufactured for welded applications.
6. Weldolets may be used for 5 inches and larger pipe provided all slag is removed from inside the pipe.
7. Weld-in nozzles may be used for branch connections to mains and where approved by Engineer.
8. Use all long radius welding elbows for expansion loops and bends.
9. Use long radius reducing welding elbows 90 degrees bends and size changes are required.

D. Joining Method - Couplings:
1. Compression and split sleeve:
   a. Install coupling to allow space of not less than 1/4 inches but not more than 1 inch.
   b. Provide harnessed joint.
      1) Use joint harness arrangements detailed in AWWA M11.
      2) Provide ASTM A108 Carbon Steel ASTM A276 restraint end rings per manufacture’s recommendations for Split sleeve type couplings.
   c. Design harness assembly with adequate number of tie rods for test pressures indicated in Section 40 05 00 and allow for expansion of pipe.
   d. Provide ends to be joined or fitted with compression or split sleeve couplings of the plain end type.
   e. Grind smooth welds the length of one coupling on either side of joint to be fitted with any coupling.

f. Assure that outside diameter and out-of-round tolerances are within limits required by coupling manufacturer.

2. Mechanical coupling:
   a. Arrange piping so that pipe ends are in full contact.
   b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.
   c. Provide coupling and grooving technique assuring a connection which passes pressure testing requirements.

E. Joining Method - Threaded and Coupled (T/C):
   1. Provide T/C end conditions that meet ASME B1.2 requirements.
   2. Furnish pipe with factory-made T/C ends.
   3. Field cut additional threads full and clean with sharp dies.
   4. Leave not more than three pipe threads exposed at each branch connection.
   5. Ream ends of pipe after threading and before assembly to remove burrs.
   6. Use Teflon thread tape on male thread in mating joints.

F. Support exposed piping in accordance with Section 40 05 00.

G. Install buried piping per Section 40 05 00.

3.2 FIELD QUALITY CONTROL

A. Test piping systems in accordance with Section 40 05 00.

END OF SECTION

SECTION 40 05 51

COMMON REQUIREMENTS FOR PROCESS AND UTILITY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valving and valving appurtenances.

B. Related Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 09 96 00 - High Performance Industrial Coatings.
3. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
4. Section 40 05 57 - Actuators for Process Valves and Gates.
5. Section 40 05 52 - Miscellaneous Valves.
6. Section 40 05 61 - Gate Valves.
7. Section 40 05 63 - Ball Valves.
8. Section 40 05 64 - Butterfly Valves.

1.2 REFERENCES

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B1.20.1, Pipe Threads, General Purpose.
   b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   d. B16.34, Valves-Flanged, Threaded and Welding End.
2. ASTM International (ASTM):
   a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. American Water Works Association (AWWA):
   a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.
   b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Standard for Rubber-Seated Butterfly Valves.
   d. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
   e. C550, Standard for Protective Coatings for Valves and Hydrants.
   f. C606, Standard for Grooved and Shouldered Joints.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. MG 1, Motors and Generators.

1.3 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. See Section 40 05 57 - Actuators for Process Valves and Gates.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.

c. Valve pressure and temperature rating.
d. Valve material of construction.
e. Special linings.
f. Valve dimensions and weight.
g. Valve flow coefficient.

B. Informational Submittals:
1. Test reports if required in the individual valve specification.

C. Closeout Submittals:
1. Operation and Maintenance Data:
a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

A. Refer to individual valve Specification Sections.

2.3 FABRICATION

A. End Connections:
1. Provide the type of end connections for valves as required in the Piping Schedules presented in Section 40 05 00 or as shown on the Drawings.
2. Comply with the following standards:
a. Threaded: ASME B1.20.1.
b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207, Class D.
c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
d. Soldered: ASME B16.18.
e. Grooved: Rigid joints per Table 5 of AWWA C606.

B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.

C. Nuts, Bolts, and Washers:
1. Wetted or internal to be bronze or stainless steel.
a. Exposed to be zinc or cadmium plated.
2. Buried:
a. T-Bolts for mechanical joints: Per AWWA/ANSI C111/A21.1
b. Other bolts and nuts: ASTM A307 ASTM A193/A194 Grade B8 Class 1.
c. Wax Tape Coatings per AWWA C217.
3. Exposed: Mechanical galvanized ASTM B695, Class 40 ASTM A193/A194 Grade B8, Class 1.
4. Heads and dimensions per ASME B1.1.
5. Threaded per ASME B1.1.
6. Project ends 1/4 to 1/2 inches beyond nuts.

D. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Painting Requirements: Comply with Section 09 96 00 for High Performance Industrial Coatings.

C. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

D. Wax Tape Coating System:

1. After installation, coat all buried nuts and bolts with a wax tape coating system in accordance with:
   a. AWWA C217 NACE International RP0375.
   b. Manufacturer’s printed instructions.
2. Cut strips of wax tape and apply them around all bolts and nuts so that there are no voids or spaces under the tape.
3. Apply a sufficient amount of tape to completely encapsulate all bare metal.

E. For threaded valves, provide union on one side within 2 feet of valve to allow valve removal.

F. Install valves accessible for operation, inspection, and maintenance.

G. Abrasive blast areas of damage due to cutting, grinding welding or drilling and coat white steel with lining/coating material to match surrounding thickness.

3.2 VALVE SCHEDULE

A. Unless shown otherwise on Drawings and drawing schedules, provide valves as follows:

Valve Tag	Service[1]	Type	Size (dia), Inches	Actuator[2]	Voltage / Phase[3]	Supply Pressure, PSI[4]	Open / Close or Modulating[5]	Comment

1. Service defined in section 40 05 00
2. M = Manual, E = Electric, P = Pneumatic, H = Hydraulic
3. 480 = 480V, 3P, 60 HZ; 120 = 120V, 1P, 60 HZ; electric actuators only
4. Pneumatic and hydraulic actuators only
5. O/C = Open/Close, MOD = modulating

END OF SECTION

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SECTION 40 05 52
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Air release and vacuum relief valves.
2. Flap Gates

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. American Water Works Association (AWWA):
   a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
   b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 05 51.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 AIR RELEASE AND VACUUM RELIEF VALVES

A. General: Conform to AWWA C512.

B. Alternate 1:

1. Water:
   a. Air and Vacuum Valve:
      1) Acceptable manufacturers:
         a) APCO Series 1900.
         b) GA Industries, Figure 992.
      2) Materials:
         a) Body and cover: Cast iron.
         b) Float: Stainless steel.
         c) Seat: Buna-N.
      3) Design requirements:
         a) Size: 2 inches [As shown].
         b) Working pressure: 250PSI.

c) Isolation Valves: For each air release valve, air-vacuum valve, and combination air valve, provide isolation valve where the air valve connects to the process pipe. Provide appropriate connection to the process pipe, such as tee fitting, appropriate tapping saddle, or other connection approved by Engineer. Isolation valves' type(s) shall be as shown or indicated in the Contract Documents. Where type is not shown or indicated, provide isolation valve type recommended by air valve manufacturer. Unless indicated otherwise in the Contract Documents, isolation valve shall be same materials required for associated air valve and appropriate for the valve's service, environment, and use. Where isolation valve size is not expressly shown or indicated, unless otherwise recommended in writing by air valve manufacturer and approved by Engineer, isolation valve diameter shall be the same as nominal size of associated air valve. Isolation valves shall have rigid-type connections to process pipe and air valve, that support disassembly for maintenance and troubleshooting.

b. Combination Air Release and Vacuum Valve:

1) Acceptable manufacturers:

a) GA Industries, (Figure 960 for the 10" CAV),

b) APCO Series AVV 10" 1800K with flanged inlet for the 10" CAV

c) Val-Matic (110F/38 for the 10" CAV).

d) Nelson

e) Av-Tek

f) Approved Equal

2) Design requirements:

a) Size: 2", 4" and 10" [As shown].

b) Working pressure: 150 PSI.

c) Provide isolation valve, type as shown.

C. Alternate 2:

1. Water:

a. Air Release and Vacuum Valve:

1) Acceptable manufacturer:

a) Vent-O-Mat RBXb Air Release and Vacuum Break Anti-shock air valve.

2) Materials:

a) Top and lower flange: Mild steel, fusion bond epoxy coated.

b) Barrel: 304 stainless steel.

c) Floats: High density polyethylene.

d) Float seats and seals: Nitrile or EPDM.

e) Nozzle seat: Natural rubber.

f) All wetted internal metal parts: 304 stainless steel.

b. Design requirements:

1) End connection:

a) 2 inches and smaller: Threaded.

b) 3 inches and larger: Flanged.

2) Provide isolation valve, type as shown.

2.3 BACKFLOW PREVENTERS (FLAP GATES)

2.4 ACCESSORIES

A. Furnish any accessories required to provide a completely operable valve.

2.5 FABRICATION

A. Completely shop assemble unit including any interconnecting piping, speed control valves, control isolation valves and electrical components.

B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

2.6 MAINTENANCE MATERIALS

A. Provide one set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: See Specification Section 01 61 03 and Specification Section 40 05 51.

B. Air Release, Vacuum Relief, and Pressure Relief Valves:

1. Pipe exhaust to a suitable disposal point.
2. Where exhausted to a trapped floor drain, terminate exhaust line 6 inches minimum above floor.

C. Float-Operated Valves: Install baffle around float to minimize turbulence adjacent to float.

3.2 REPAIR AND REHABILITATION (FLAP GATES):

A. Preparation and assessment of existing conditions:

1. Provide a method of lifting and supporting flap when removing hinge pin.
2. Remove flap gate.
3. Visually inspect for flatness, warpage and corrosion.

B. Clean and Repair

1. Wire brush and/or pressure wash debris and mud from all surfaces.
2. Ensure grease zerks are functioning.
3. Lubricate hinge with NGLI #3 waterproof grease.
4. Prepare mating surfaces to within plus or minus 1/64” of a true theoretical flat plane.
5. Reassemble and prepare the mating surfaces until the flap seats properly to form a seal.
6. Adjust shaft and hinge until flap rotates freely without binding,

3.3 FIELD QUALITY CONTROL

A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.

B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

END OF SECTION

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SECTION 40 05 57
ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Actuators for valves and gates.
   a. Manual actuators.

B. Related Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment - Basic Requirements.
2. Section 40 05 51 - Common Requirements for Process and Utility Valves.
3. Section 40 05 52 - Miscellaneous Valves.
4. Section 40 05 61 - Gate Valves.
5. Section 40 05 63 - Ball Valves.
6. Section 40 05 64 - Butterfly Valves.

1.2 REFERENCES

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A266, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. American Water Works Association (AWWA):
   a. C500, Standard for Metal-Seated Gate Valves for Water Supply Valves.
   b. C550, Standard for Protective Coatings for Valves and Hydrants.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Provide actuators that are fully compatible with valve or gate for which it is intended.
2. Contractor to coordinate valve/gate manufacturer and actuator manufacturer for proper sizing of actuator.
   a. See below for safety factors.
3. Mounting hardware by actuator manufacturer.
4. Install actuators at valve/gate manufacturers facility to allow for testing prior to shipping to site.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to individual Articles for materials.

2.2 VALVE ACTUATORS

A. Valve Actuators - General:

1. Provide actuators as shown on Drawings or specified.
2. Counter-clockwise opening as viewed from the top.
3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
   a. Paint in a contrasting color such as white.

4. Size actuator to produce required torque with a maximum pull of 80 pounds at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 pounds on handwheel or chainwheel or 300 foot-pounds torque on the operating nut.
5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.
6. Valve Lockout Devices:
   a. Device manufactured from same material as valve actuator, preventing access to valve actuator, to accept lock shackle.
7. Extension stem:
   a. Install where shown or specified.
   b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
   c. Pin all stem connections.
   d. Center in valve box or grating opening band with guide bushing.

B. Exposed Valve Manual Actuators:
1. Provide for all exposed valves not having electric, cylinder or electro-hydraulic actuators.
2. Provide handwheels for gate and globe valves.
   a. Size handwheels for valves in accordance with AWWA C500.
3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 inches diameter and smaller.
   a. Provide lever actuators for butterfly valves with a minimum of five intermediate lock positions between full open and full close.
   b. Provide at least two levers for each type and size of valve furnished.
4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 inches diameter and larger.
5. Provide gearing for gate valves 18 inches and larger in accordance with AWWA C500.
6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
7. Provide chain actuators for valves 6 feet or higher from finish floor to valve centerline.
   a. Cadmium-plated chain looped to within 3 feet of finish floor.
   b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
   c. For smaller valves with lever or handle actuators, provide offset tee handles with attached chain for operation from the operating floor.
   d. Provide chain storage device for each chain.
      1) Chain-Away Bucket by Chain Away Corporation.
      2) Chain-Up by Trumbull Manufacturing.
      3) Or equal.
8. Provide cast iron floor stands where shown on Drawings.
   a. Stands to be furnished by valve manufacturer with actuator.
   b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Location and Orientation:
1. Provide actuators and operators as shown on the Drawings.

2. When not expressly shown on the Drawings, orient valve actuators so valve operator is in a position reasonably convenient for facility personnel.
    a. Unless otherwise shown, install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.
3. When orientation of actuator, operator location, or both are unclear, submit to Engineer a request for interpretation and obtain Engineer's response before furnishing the associated Submittal and in no event, later than purchasing the associated valve and actuator.
4. Contractor is responsible for costs and delays incurred to remedy valve actuators furnished or installed in inconvenient or difficult-to-access positions and locations unless the Contract Documents require otherwise.
5. Contractor is not responsible for providing permanent platforms, stairs, or other extraordinary, permanent access measures unless so required by the Contract Documents.

C. Touch Up Painting Requirements:

1. Repair scuffs and scratches on factory-applied finishes using materials furnished by the actuator manufacturer, applied in accordance with the written instructions of both the actuator manufacturer and the Supplier of the touch-up material(s).

END OF SECTION

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SECTION 40 05 61
GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gate valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Water Works Association (AWWA):
   a. C504, Standard for Rubber-Seated Butterfly Valves.
   b. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
   c. C515, Standards for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Systems.
   d. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

1.3 DEFINITIONS

A. OS&Y: Outside Screw and Yoke.

B. NRS: Non-rising Stem.

C. RS: Rising Stem.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 05 51.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, NON-POTABLE, AND WASTEWATER)

A. Resilient Wedge Gate Valves, 2 to 48 inches (Water, Wastewater Application):

1. Comply with AWWA C509 or C515.
2. Materials:
   a. Body, gate: Cast iron or ductile iron
   b. Resilient wedge: Fully encapsulated rubber wedge. Ethylene Propylene Diene Monomer (EPDM).
3. Design requirements:

a. Minimum 150 PSIG working pressure.
b. Counter clockwise open rotation.
c. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
1) Comply with AWWA C550.

4. Manufacturers:
a. Clow.
b. Mueller.
c. Kennedy.
d. M & H
e. Or Equal.

5. Design requirements:
a. Working pressure (WOG non-shock):
1) 2 to 24 inches: 150 psi.

2.3 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.
1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 51 for actuator requirements.

2.4 FABRICATION

A. General:
1. Provide valves with clear waterways the full diameter of the valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

END OF SECTION

SECTION 40 05 63
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. A48, Standard Specification for Gray Iron Castings.
   b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   c. A276, Standard Specification for Stainless Steel Bars and Shapes.
   d. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   e. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
2. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
   a. SP-110, Ball Valves; Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

B. PTFE: Polytetrafluoroethylene.

C. RPTFE: Reinforced PolyTetraFluoroEthylene.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 05 51.
2. Test results for AWWA valves.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 METALLIC BALL VALVES 1/4 TO 3 INCHES DIAMETER

A. Comply with MSS SP-110.

B. Manufacturers:

1. Apollo.
2. Jamesbury.
3. Watts.
4. Stockham.
5. Nibco.

C. Materials (All Stainless Steel):

1. Body: Two-part stainless steel, ASTM A351 CF8M.
2. Ball: Stainless steel ASTM A276.
3. Seats: RPTFE or glass-filled PTFE or PTFE.

D. Design Requirements:

1. Two-position lockable handle.
2. Stem with blowout-proof design.

2.3 SOURCE QUALITY CONTROL

A. Product Testing: MSS SP-110.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

3.2 FIELD QUALITY CONTROL

A. For AWWA C507 ball valves and in accordance with Specification Section 01 75 00, employ and pay for services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by this Specification Section.
2. Supervise adjustments and installation checks.
3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
4. Conduct startup of equipment and perform operational checks.
5. Provide Owner with a written statement that manufacturer's equipment has been installed properly, has been started up, and is ready for operation by Owner's personnel.

END OF SECTION

SECTION 40 05 64
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Butterfly valves.

B. Related Sections include but are not necessarily limited to:

1. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
2. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 REFERENCES

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
   b. B16.47, Large Diameter Steel Flanges: NPS 26 through NPS 60.
2. ASTM International (ASTM):
   a. A48, Standard Specification for Gray Iron Castings.
   b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   c. A276, Standard Specification for Stainless Steel Bars and Shapes.
   d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   e. A436, Standard Specification for Austenitic Gray Iron Castings.
   f. A536, Standard Specification for Ductile Iron Castings.
3. American Water Works Association (AWWA):
   a. C504, Standard for Rubber-Seated Butterfly Valves.
   b. C519, Standard for High-Performance Butterfly Valves – 3 In. through 60 In.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. See Specification Section 40 05 51.

B. Informational Submittals: Submit the following:

1. For valves 8 inches and larger specified to comply with AWWA C504 and C516, furnish "Affidavit of Compliance" with Owner in accordance with AWWA C504 and C516.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
   a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. General Use BFVs:

a. DeZurik.
b. Mueller/Lineseal.
c. Pratt, a Mueller Water Company.
d. Bray.

2. High Performance BFVs for in the High-Lift System:
   a. Av-Tek
   b. Stayflow
   c. DeZurik.
   d. Or approved equal.

2.2 GENERAL USE BUTTERFLY VALVES

A. For use in all locations, except in the High-Lift system where high-performance butterfly valves are required.

B. Comply with AWWA C504, except as noted in this Specification Section.

C. Materials:

1. Valve bodies:
   a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
   b. Wafer valves may be constructed of ASTM A48, Class 40 cast iron.
2. Valve shafts:
   a. Shaft and pin material: Type 304 stainless steel.
   b. Bushings/Packing/O-rings: EPDM, Nylatron, RTFE or TFE.
   c. Bearings: Nylatron, Reinforced TFE or equal.
3. Valve discs:
   a. Cast iron with welded 304 stainless edge or Type 304 Stainless Steel disk.
4. Valve seats:
   a. Water: EPDM or Hycar.
5. Shaft bearing: Bronze, TFE-coated stainless steel or reinforced TFE.
6. Shaft seal in addition to any sealing provided by seat: Suitable synthetic rubber rings or PTFE V-ring suitable for operating conditions.

D. Design Requirements:

1. Shaft design
   a. Valves 16-inch and less: One-piece.
   b. Valves greater than 16-inch: one-piece or two-piece (stub shaft).
2. Seat type: Resilient.
   a. Valves 24 inch and greater: Field adjustable without dismantling actuator, disc or shaft, and without removing valve from line.
3. Body type (exposed and submerged):
   a. Wafer in sizes up to 20 inch if max working pressure 50 psi and less.
   b. Flanged.
      1) Fully tapped anchor lugs drilled per ASME B16.5.
   c. Valves 24 inch and greater: short body flanged.
4. Working Pressure Rating (exposed and submerged): 150 psi (Class 150B per AWWA C504)
5. Direct buried valves:
   a. All valves: Working pressure rated for 150 psi (Class 150B per AWWA C504).
   b. End connection: Mechanical joint.

6. Offset disc design to provide 360-degree sealing.

2.3 HIGH PERFORMANCE BUTTERFLY VALVES

A. In the High-Lift system, high performance butterfly valves with an offset disc design shall be used.

B. Design Requirements:

1. Comply with AWWA C504 lay lengths and testing and as noted herein.
2. Flanged connections - AWWA Class 150B.
3. Shaft:
   a. One-piece shaft.
   b. Minimum shaft diameter to conform to AWWA C504.
4. Double offset design where the centerline of the disc is horizontally and vertically offset from the body seat.
5. Offset disc design to provide 360-degree sealing.

C. Materials of construction:

1. Body: Ductile iron – ASTM A536 or thickness according to AWWA C504Carbon steel – ASTM 216 Grade WCB].
2. Disc: Ductile iron – ASTM A536 or ASTM A395 or Type 316 stainless steel.
3. Shaft and pins: 17-4 PH stainless steel or Type 316 stainless steel or 2205 Duplex Stainless Steel.
4. Seals:
   a. PTFE or EPDM on disc, or
   b. Stainless Steel 316 on disc.
5. Backing ring: Stainless steel.
6. Bushings/Bearings: TFE/Glass liner with a 316 Stainless steel shell or bronze.
7. Seat:
   a. Seat-in-body – EPDM (with Stainless Steel seal on disc)
   b. Metallic seat (304 stainless steel or 316L NiCr Stainless Steel) with EPDM seal on disc
8. End connection: Flanged.

2.4 ACCESSORIES

A. Refer to Drawings and/or valve schedule for type of actuators.

1. Furnish hand-wheel, self-locking worm gear type actuator (AWWA C540) with position indicator.
2. Provided by valve manufacturer and installed at valve manufacturer's facility.

B. Refer to Section 40 05 57 for actuator requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 40 05 51.

END OF SECTION

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SECTION 40 05 66
CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Swing check valves, 18 -inch diameter.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 REFERENCES

A. Referenced Standards:

1. American Water Works Association (AWWA):
   a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Valve Manufacturers:
   a. Manufacturer shall be a business regularly engaged in manufacturing and furnishing check valves of the type required and similar equipment.
   b. Manufacturer shall be able to document having furnished not less than 50 check valves, of the type required, of size equal to or larger than those required for the Work, during the past five years.
   c. When requested by Engineer, submit qualifications statement indicating manufacturer's record of manufacturing and furnishing check valves of the types and sizes required and furnish documentation of compliance with qualifications requirements of this Article.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. In accordance with Section 40 05 51.

B. Informational Submittals: Submit the following:

1. In accordance with Section 40 05 51.
2. Manufacturer's Instructions:
   a. Manufacturer's written instructions for delivery, handling, storage, installation, and startup.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
   a. Submit in accordance with Section 01 78 23 - Operations and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 RESILIENT HINGED CHECK VALVES: 18 INCH

A. Flanged connection: AWWA C207 Class D or ASME B16.1, Class 125 (175 psi)

B. Acceptable Manufacturer:

1. APCO Series 100A.
2. Val Matic Swing-Flex.

3. Flomatic Flo-Flex 745
4. Or equal

C. Materials:

1. Body and cover: Ductile iron, cast iron.
2. Flapper: Buna-N (Acrylonitrile Butadiene) (NBR), steel reinforced.

D. Accessories:

1. Position indicator

2.2 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections:

1. Perform manufacturer's standard factory tests and inspections on materials and equipment furnished. Correct defects prior to shipment to the Site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation – General:

1. Provide check valves at locations shown and indicated in the Contract Documents.
2. Install in accordance with the Contract Documents and manufacturer's written instructions. In event of conflict between the Contract Documents and manufacturer's written instructions, obtain written interpretation or clarification from Engineer.
3. Comply with:
   a. Section 01 61 03 - Equipment - Basic Requirements.
   b. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   c. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
4. Before installing, ensure each check valve is clean and free of dirt and debris.

3.2 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

1. Promptly after installing, before installing connecting pipe, verify proper and free operation of check valve.
2. Hydrostatically test check valves together with associated piping.
3. To extent practical, prior to Substantial Completion, verify proper operation of each installed check valve.

END OF SECTION

SECTION 40 42 00
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation:
   a. Duct insulation.
2. Adhesives, mastics, sealants, and finishes.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 40 05 07 - Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
   a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
   b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
   c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
   d. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
   e. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
   f. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
   g. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
   h. E96, Standard Test Methods for Water Vapor Transmission of Materials.
   i. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
   j. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
   k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   l. E119 Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
   m. E136, Combustion Characteristics of Building Materials in a Vertical Tube Furnace.
   n. E162, Surface Flammability of Materials.
   o. E814, Through-Penetration, 2-Hour Firestop Test.
   p. E2336: Standard Test Methods Fire Resistive Grease Duct Enclosure Systems.
2. ISO 6944-1985, Method of Determining Fire Resistance of Ventilation Ducts.
3. National Fire Protection Association (NFPA):
   a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
4. Underwriters Laboratories, Inc. (UL):
   a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
5. National Commercial and Industrial Insulation Standards (2013 seventh edition).
   a. Published by Midwest Insulation Contractors Association (MICA).

b. Endorsed by National Insulation Association (NIA).
c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.
2. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
3. Certifications: Products will meet the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ductwork insulation:
   a. CertainTeed.
   b. Johns Manville.
   c. Owens Corning.
2. Adhesives, mastics, sealants, and finishes:
   a. Foster Products.
   b. Childers.
   c. Dow Corning.
   d. Johns Manville.
   e. Knauf.

2.2 DUCTWORK INSULATION: FIBERGLASS

A. Flexible Insulation:

1. Material: Commercial-grade fiberglass thermal insulation, formaldehyde free.
2. Scheduled thickness and installed R-value. Installed R-value when compressed to a maximum of 25% following recommended duct wrap stretch outs.
3. Factory-applied foil scrim vapor barrier facing.
4. Average thermal conductivity not to exceed 0.27 (BTU-IN)/(HR-FT^2-DEGF) at a mean temperature of 75 degrees F (installed).
5. Fungi and bacteria resistance:
   a. ASTM C1338.
   b. Does not breed or promote growth.
6. Fire hazard classification:
   a. UL 723, ASTM E84, NFPA 255.
   b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
7. Basis of design: Johns Manville Microlite fiberglass duct wrap insulation.

B. Semi-Rigid Insulation for Indoor Installation:

1. Scheduled thickness and R-value.

2. Factory applied vapor barrier facing-white scrim foil.
3. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT^2-DEGF) at a mean temperature of 75 degrees F.
4. Fungi and bacteria resistance:
   a. ASTM C1338.
   b. Does not breed or promote growth.
5. Moisture adsorption:
   a. ASTM C553.
   b. Not greater than 0.5% moisture by volume when exposed to moisture laden air at 120 degrees F and 96% RH.

C. Semi-Rigid Insulation for Outdoor Installation:
1. Scheduled thickness and R-value.
2. Factory-applied foil scrim vapor barrier facing.
3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT^2-DegF) at mean temperature of 75 degrees F.
4. Minimum density: 3 pounds/CUFT.
5. Fungi and bacteria resistance:
   a. ASTM C1338.
   b. Does not breed or promote growth.
6. Basis of Design: Johns Manville #815 SPIN-GLASS fiberglass duct insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Piping below ground covered with earth will not be insulated.
2. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
3. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
   a. Consider ductwork, piping and equipment above ceilings as concealed.
4. Provide release for insulation application after installation and testing is complete.
   a. Apply insulation on clean, dry surfaces after inspection.
5. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
6. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
   a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
   b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
7. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Ductwork Insulation - Fiberglass:
1. Flexible insulation:
   a. Butt edges tightly.
      1) Secure insulation with Benjamin Foster 85-20 adhesive applied in 6 inches strips on 12 IN centers and/or pins, applied on not more than 18 inches centers so that the insulation conforms to the duct surfaces uniformly and firmly.

b. Seal joints with facing overlap or 4 inches wide strips of like facing material adhered and stapled in place.
c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85-20.
d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.

2. Semi-rigid insulation:
   a. Impaling over pins.
      1) Apply insulation with edges tightly butted.
      2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.
      3) Clip pins off close to clip.
      4) Space pins as required to hold insulation firmly against duct surface but not less than one pin per 1.5 square feet.
      5) Seal joints and speed clips with 3 inches wide strip of facing adhered with Benjamin Foster 85-20 adhesive.
   b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive.
      1) Cover the entire surface of duct with adhesive.
      2) Use corner metal angle to protect edge of insulation.
      3) Protect edge of insulation.
      4) Seal joints as above.
   c. For outdoor application finish with Benjamin Foster #4610 weatherproof mastic with white glass fabric membrane.

3.2 REPAIR

A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

A. Ductwork:
   1. Fiberglass.

DUCT SERVICE	INSULATION AND THICKNESS	MINIMUM R-VALUE ($(HR\text{-}FT^2\text{-}DEGF)/BTU$)
Supply and return air ducts inside building	2 inches flexible with vapor barrier	6.0
Supply and return air ducts outside building and where exposed to atmospheric air	2-1/2 inches semi-rigid for outdoor installation	12.0
All other ductwork	Uninsulated	N/A

END OF SECTION

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Basic requirements for complete instrumentation system for process control.
2. Requirement for Contractor to subcontract the Process Control System portion of the Work to a “Systems Integrator”.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 10 14 00 - Identification Devices.
2. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. The International Society of Automation (ISA):
   a. 7.0.01, Quality Standard for Instrument Air.
   b. S5.1, Instrumentation Symbols and Identification.
   c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
   d. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
   e. 62443-3-3 Security for Industrial Automation and Control Systems, Part 3-3: System Security Requirements and Security Levels
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
   a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.
5. National Institute of Standards and Technology (NIST)
   a. SP 800-82, Guide to Industrial Control Systems (ICS) Security

B. Qualifications:

1. System Integrator:
   a. Experience:
      1) Have satisfactorily provided control system integration for a minimum of five projects of similar magnitude and function.
   b. Certification:
      1) Control Systems Integrators Association (CSIA) Certification

c. Qualification:

1) Regularly engaged in the design and the installation of process control and instrumentation systems and their associated subsystems .

2) Maintains a permanent, fully staffed and equipped service facility within 300 miles of the project site with full time employees capable of designing, documenting, fabricating, installing, calibrating, programming, configuring, providing training services, and testing the systems specified herein.

3) Capable of responding to on-site problems within 24 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.

C. Miscellaneous:

1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.3 DEFINITIONS

A. Calibrate: To standardize a device so that it provides a specified response to known inputs.

B. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

C. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

E. System Integrator: A Contractor/Subcontractor who combines instrumentation, control devices, hardware, software, and networking products from multiple vendors to provide a fully functioning control system.

1.4 SYSTEM DESCRIPTION

A. Control System Requirements:

1. This Specification Section provides the general requirements for the control system.

2. The control system consists of all primary elements, transmitters, switches, controllers, computers, communication devices, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.

B. Utilization of System Integrator:

1. Retain a System Integrator subcontractor to provide a fully functioning control system.

a. The System Integrator shall be responsible for the provision of an integrated control system fully functioning in accordance with the requirements of the Contract Documents.

2. Provide all required coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

1.5 SUBMITTALS

A. Shop Drawings:

1. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
   a. Facsimile information is not acceptable.
2. Limit the scope of each submittal to one Specification Section.
   a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
   b. Do not provide any submittals for Specification Section 40 61 13.
3. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Equipment catalog cut sheets.
   c. Instrument data sheets:
      1) ISA S20 or approved equal.
      2) Separate data sheet for each instrument type.
   d. Materials of construction.
   e. Minimum and maximum flow ranges.
   f. Pressure loss curves.
   g. Physical limits of components including temperature and pressure limits.
   h. Size and weight.
   i. Electrical power requirements and wiring diagrams.
   j. NEMA rating of housings.
   k. Submittals shall be marked with arrows to show exact features to be provided.
4. Comprehensive asset inventory of all networked components:
   a. Provide in Excel spreadsheet format.
   b. Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in asset inventory.
   c. Include:
      1) Device ID.
      2) Manufacturer.
      3) Model Number.
      4) Serial Number.
      5) IP Address.
      6) Device Use description.
      7) Firmware.
5. Network Diagrams:
   a. Provide in both AUTO CAD and PDF formats.
   b. Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in Network Diagrams.

c. Logical Network Diagram(s):
    1) Depict information flow through network(s), and include:
        a) Major network devices, subnets, and VLANs.
        b) Include all wireless communication devices.
        c) Include the following information for each networked device:
            (1) Device ID.
            (2) Device description.
            (3) Manufacturer/model number.
            (4) IP address.
            (5) Ports and Protocols
d. Physical Network Diagram(s):
    1) Show all network components, ports, protocols, connections and cables.
        a) Include all wireless communication devices.

6. Refer to Section 01 81 33 – Cyber Security Requirements for other required cyber security related submittals.
7. Comprehensive set of wiring diagrams as specified in Section 40 67 00.
8. Panel fabrication drawings as specified in Section 40 67 00.
9. PLC equipment drawings.
10. HMI graphics.
11. Nameplate layout drawings.
12. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
    a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
13. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
    a. Furnish electronic files on owner's designated electronic media.
    b. Drawings in AUTO CAD format.
14. Provide a parameter setting summary sheet for each field configurable device.
15. Certifications:
    a. Documentation verifying that calibration equipment is certified with NIST traceability.
    b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
        1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
16. Testing reports: Source quality control reports.

B. Qualifications Submittal:
    1. Documentation verifying contractor/subcontractor adherence to specified certifications and qualifications

C. Contract Closeout Information:
    1. Operation and Maintenance Data:

a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

2. All Shop Drawings shall be modified with as-built information/corrections.
3. Instrumentation and Control Equipment Operation and Maintenance Manual Content:
   a. Provide a printed copy of the following sheets following the Equipment Record sheets or ISA Data Sheets.
      1) Loop Check-out Sheet.
      2) Instrument Certification Sheet.
      3) Final Control Element Certification Sheet.
   b. Provide the following detailed information:
      1) Use equipment tag numbers from the Contract Documents to identify equipment and system components.
      2) As-constructed fabrication or layout drawings and wiring diagrams.
      3) As-constructed network asset inventory, and physical and logical network diagrams.
         a) Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of this information.
      4) Software Licenses:
         a) Provide a single Software Licenses submittal with documentation of the software licenses for all software provided.
         b) Spreadsheet including license numbers, registration records, expirations for service contracts,, and name of owner representative to whom each software has been registered with the OEM as the licensee.
      5) Software Recovery and Reconstitution Images:
         a) For each control system component on which software is installed or configured under this project, provide a recovery image of the software or configuration. This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software.
   c. Password Summary Report:
      1) Provide a Password Summary Report documenting the administrative password for each device and describing the procedure to change the password for each device. Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.
      2) Provide listing of all temporary Systems Integrator usernames setup for each device.
   d. Additional information as required in the associated equipment or system Specification Section.
4. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing for control system components in accordance with the area designations provided on the Drawings.

1. Areas designated as wet: NEMA Type 4.
2. Areas designated as wet and/or corrosive: NEMA Type 4X.
3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
   a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
      1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
   a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
      1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
6. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless stated otherwise, system operating criteria are as follows:

1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5% full travel.
2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3% of full scale over a 6:1 operating range.
4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5% of full travel regardless of force required to position final element.
5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0% of full scale.
6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 ACCESSORIES

A. Provide identification devices for instrumentation system components in accordance with Specification Section 10 14 00.

B. Provide corrosion resistant spacers to maintain 1/4 inches separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per the requirements of the Electrical design.

3.2 FIELD QUALITY CONTROL

A. See Section 01 75 00 and Section 40 61 21.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

Loop Check-out Sheet

Project Name:		Owner's Project No. (if applicable):	Page of
Project Owner:		Regulatory Agency Project No. (if applicable):	
HDR Project No.:		Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

FINAL CONFIGURED SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

_____

_____

_____

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____

(Work Performed By)

Instrument Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

_____

_____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

Final Control Element Certification Sheet

Project Name:	Owner's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Tag No.	
Description:	
Manufacturer:	
Model No.	
Serial No.	

Actuator:	Pneumatic: _____ Electric: _____
Positioner:	Direct: _____ Reverse: _____
Positioner:	Input: _____ Output: _____
I/P Converter:	Input: _____ Output: _____
Valve to	_____ on air failure
Valve to	_____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**TRAVEL**	**ERROR (% of full travel)**	**INPUT**	**TRAVEL**	**ERROR (% of full travel)**
0%						
25%						
50%						
75%						
100%						

Remarks: _____

_____

_____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

SECTION 40 61 93
PROCESS CONTROL SYSTEM INPUT-OUTPUT LIST

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Process Control System (PCS) PLC Input/Output (I/O) List description.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 40 61 13 - Process Control System General Requirements.
2. Section 40 63 43 - Programmable Logic Controllers.
3. Section 40 61 96 - Process Control Descriptions.
4.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. The International Society of Automation (ISA):
   a. 5.1, Instrumentation Symbols and Identification.

1.3 SUBMITTALS

A. Shop Drawings:

1. Any proposed deviations from the I/O List format, content and attributes stipulated in this Section shall be submitted for approval. I/O List development shall not proceed until the deviation has been approved.
2. Pre-fabrication I/O Lists for approval.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. I/O Lists:
   a. Post-Commissioning Final I/O Lists.
   b. Submit I/O Lists in PDF and native format Microsoft Excel indexed by Area, Panel, and Point Description.

PART 2 - PRODUCTS

2.1 I/O LIST

A. The I/O List herein contains I/O point information derived from the Contract drawings and specifications.

B. The I/O List shall be used as the starting point in the development of the final PLC I/O database.

1. The I/O list does not include internal software points generated by the control system and is used solely within the control system.

C. The I/O List is organized in columns as follows:

1. I/O TAG describes the point name that will be used throughout the control system to identify the point.
2. P&ID references the Process and Instrumentation Diagram on which the point is depicted in relation to the process and equipment.

3. I/O TYPE denotes the signal type such as analog input or output, discrete input or output, pulse, etc.
4. INTERFACE denoted the method of communication (hardwired, via data-link, etc.).
5. POINT DESCRIPTION is a concise English language description of the point's function in in relation to the process in terms that a user can easily understand.
6. PANEL indicates the control panel in which the I/O module is located.
7. FIELD DEVICE TAG is the tag assigned to the associated field instrument (if applicable).
8. SIGNAL TYPE is the type of electrical signaling used.
9. CALIBRATED RANGE is the minimum and maximum (range) limit in engineering units of an analog input or output signal.
10. ENGINEERING UNITS lists the units associated with the point value.
11. DIGITAL ZERO STATE is the state descriptor associated with the open or zero (0) state of a discrete signal. Ex. ALARM, OFF, HIGH, FAILED.
12. DIGITAL ONE STATE is the state descriptor associated with the closed or one (1) state of a discrete signal. Ex. NORMAL, ENERGIZED, FLOW.
13. INTERPOSING RELAY indicates if a relay needs to be interposed between the control system and the field signal.
14. NOTES is for any pertinent notations that help in identification or understanding of the signal source, features or new/existing status.
15. REV indicates the number of revisions of that I/O point since the bid.

D. I/O List:

1. Refer to Appendix 40 61 93A.

PART 3 - EXECUTION

3.1 I/O DATABASE DEVELOPMENT

A. The Systems Integrator shall develop the complete I/O List containing all information needed to facilitate panel building, testing and programming, and the fully document the I/O layout and interconnections.

B. The Systems Integrator shall obtain the Owner's existing tag naming conventions, abbreviations, facility codes, standard state descriptors, and other relevant information prior to creating the I/O List.

C. Prior to the start of PLC panel fabrication, the Systems Integrator shall submit an I/O List for review and approval

D. The I/O List shall include for each I/O point, at minimum, all information as listed in Section 2.1.C.

E. Maintain a copy of the complete I/O List with modifications during construction in native file format. I/O List shall be accessible to Owner and Engineer upon request.

F. Following successful project Commissioning, submit an "As Installed" final I/O List, with all fields representing the updated information, including all field updated information.

3.2 I/O HARDWARE CONFIGURATION

A. Partition the signals among I/O modules as described in Section 40 63 43 to provide enhanced process control and monitoring resiliency.

3.3 I/O POINT DATA FIELDS

A. Information in the I/O List data fields may be subject to review and modification by the Owner or Engineer during the Submittal review phase.

1. Incorporate changes as directed by the reviewer through the system and associated documentation, at no additional cost to the Owner, subject to the following limitations:

a. Requested modifications shall be limited to 20% of the total number of I/O points.
   1) This 20% shall not include changes to the I/O List prior to the Submittal review.
   2) Corrections for errors by the Systems Integrator shall not count toward the 20% modification limit.
b. Each unique change shall count as one modification.
   1) For example, modifying the description, range, and engineering unit for one analog input counts as three separate modifications.
c. Analog input alarm limit adjustments shall not count as modifications.

END OF SECTION

APPENDIX 40 61 93A

I/O LIST

40 63 43A - IO List.xlsx

SECTION 40 61 96
PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section is intended to describe the functional and operational requirements of the process being monitored and controlled by the process control system, and to define the Contractor's responsibilities related to the work described herein.

B. Section Includes:

1. Document Maintenance and Content Requirements.
2. Process Control Description content and structure.
   a. Process Control Description for each system includes:
      1) Reference Documents.
      2) Major Equipment and Field Instruments.
      3) Overview Description.
      4) Detailed Process Control Descriptions.
      5) Response to Instrument or Equipment Failures.
      6) Displays at HMI/OIT.
      7) Report Descriptions.

C. Related Sections include but are not necessarily limited to:

1. Section 40 61 13 – Process Control Systems General Requirements.

D. General Requirements:

1. The Process Control Descriptions describe the operational interface and functional requirements of the Process Control System (PCS) and of the control loops and other PCS functions represented in the Contract Documents.
2. The Process Control Descriptions do not necessarily address every PCS point or alarm point associated with the process or equipment. Provide and incorporate all hard-wired, networked and internal equipment alarms as shown on the P&IDs, the I/O Lists, the Instrument Lists, or elsewhere within the Contract Documents, as well as other points required to meet the intent of the system control.
3. The process control descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the Drawings and other Specification Sections.
4. The Process Control Descriptions shall not be considered equal to a bill of materials.
5. Provide instrumentation hardware and software as necessary to perform control functions specified herein and shown on Drawings.
6. Unless otherwise specified, the following general requirements apply to all process control descriptions.
   a. Analog control loops shall operate based on a standard PID controller, with the controller faceplate incorporated on the PCS HMI graphic display. The PID controller faceplate includes (but is not limited to) the following functions:
      1) Bar graphs for setpoint, process variable and percent output, poke point buttons for Auto/Manual Mode selection, and a numeric entry field with popup keypad for Operator entered values.
         a) Auto/Manual Mode selection: In Auto Mode, the output of the controller is based on the PID controller calculation. In Manual Mode, the output of the controller is operator adjustable. Switching between the PID controller's

operational modes shall be configured with setpoint tracking and bump-less transfer.

b) Compound Mode, where applicable: In the Compound Mode, the setpoint is trimmed by a remote setpoint input. This mode is used in applications requiring a cascade control loop such as level/flow.

2) When in the Automatic Mode, PID algorithms shall monitor the margin of error between the setpoint value and the actual process variable. A deviation of +/- 10% between setpoint and process variable generates a Deviation Alarm notifying the operator of the condition. The % of deviation is an adjustable value.

b. All motors (constant and variable speed) must be monitored for the associated Run, Stop, and Fail status. When the PCS initiates a run command output, the PCS logic monitors the running status feedback from the motor (starter or variable speed drive) and produces a “Fail to Run” or “Fail to Stop” alarm (as applicable) if the motor feedback does not correspond with the status of the PCS initiated command output. A PCS internal delay timer with typical preset of 15 seconds (individually adjustable) shall be configured for each logic statement to allow the motor control adequate time to comply with the output command.

1) The PCS output command is de-energized subsequent to the expiration of the alarm delay time period, i.e. a timed-out command.

c. Valves or gates with limit switch functions for position feedback: when the PCS initiates an Open/Close command output, the PCS logic monitors the position feedback and produces a “Failure to Open” or Failure to Close” Alarm (as applicable) if the valve/gate feedback does not correspond with the status of the PCS initiated command output. A PCS internal delay timer preset of 60 seconds (operator adjustable to match actual valve actuator speed) is configured for each logic statement allowing the valve/gate actuator time to comply with the output command. The timer preset requires adjustment at startup depending on the type of valve or gate and the full open to close travel time for each.

1) The PCS output command is de-energized subsequent to the expiration of the alarm delay time period, i.e. a timed-out command.

d. Analog inputs shall have a signal Out Of Range Alarm generated via a PCS internal timer when the PCS input is < 3.8 mADC or > 20.5 mADC. The alarm delay timer preset is initially set at 20 seconds. The delay preset value is operator adjustable.

e. All flow inputs shall be totalized (integrated) and logged on the PCS historian. All totalized values are displayed on the PCS HMI graphic display in the appropriate engineering units as required. Provide daily flow totals for all measured flows.

f. All equipment run times shall be totalized, displayed and logged on the PCS historian. Run times shall have a resolution of one minute and be displayed in hours and tenths of hours on the appropriate PCS HMI graphic display.

g. For each piece of process equipment controllable by the PCS, an equipment “ready” or control mode permissive signal is needed to indicate to the PCS control logic PCS control is allowed. The PCS shall monitor the Local Control Panel mounted L/R mode selector switch and control the equipment that is in the Remote mode.

h. Non-modulating motorized valves or gates shall be controllable via Open-Stop-Close buttons on HMI and OIT faceplates. The valves/gates shall be controlled in the Open and Close directions by separate PCS control signals. The PCS shall stop the Open or Close command to the actuator when the actuator reaches the respective end of travel.

i. I/O points shown on the P&IDs, I/O List or elsewhere within the Contract Documents shall be incorporated into the PCS HMI and OIT graphic displays as indicated by their function.

j. Operator entry of setpoints shall be limited to values within upper and lower operating limits corresponding to the valid operating range of the equipment. An operator-entered setpoint outside the valid range must be rejected by the PCS and the original setpoint shall be maintained until a valid value is entered. When an invalid setpoint is entered

into the system, an Invalid Value message shall appear in the setpoint entry faceplate, alerting the operator to the condition. The upper and lower range limits are adjustable.

k. In addition to the requirements specifically stated within each Process Control Description, all control software and hardware shall be provided as required to ensure the safe and reliable operation of all controlled equipment.

l. All "soft" alarms on analog signals shall reside in the PLC logic with de-bounce timers. Provide the capability to modify the soft setpoints through the HMI system with appropriate security.

m. All alarm and trip time delays shall be adjustable from the HMI system by an operator with appropriate security.

n. All process values, ranges, and setpoints described herein shall be considered "Initial values" and may be changed during installation and start-up.

o. All measured analog values shall be logged and available for trending via Operator selection at the HMI.

1.2 DEFINITIONS/ABBREVIATIONS

A. Abbreviations are defined as listed below:

A/M	Auto/Manual
ATS	Automatic Transfer Switch
DCS	Distributed Control System
DPU	Distributed Processing Unit
H/O/A	Hand-Off-Auto
H/O/R	Hand-Off-Remote
HMI	Human-Machine Interface
L/O/R	Local-Off-Remote
L/R/O	Local/Remote/Off
L/R	Local/Remote
LCP	Local Control Panel
LCS	Local Control Station
MCC	Motor Control Center
O/C	Open/Close
OI	Operator Interface (valve actuator, VFD)
OIT	Operator Interface Terminal
P&ID	Process and Instrumentation Diagram
PCS	Process Control System
PID	Proportional-Integral-Derivative
PFD	Process Flow Diagram
PLC	Programmable Logic Controller
RIO	Remote DCS or PLC Input/Output Equipment
RTU	Remote Terminal Unit
RVSS	Reduced Voltage Solid-state Starter

S/S	Start/Stop
UPS	Uninterruptible Power Supply
VFD	Variable Frequency Drive

1.3 SUBMITTALS

A. Control Screen Graphics

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Control Strategy for Record Documents:

1. Obtain this Specification Section 40 61 96 in electronic format (Microsoft Word) from Engineer at beginning of Project. Provide updated Process Control Descriptions as follows:
   a. As needed or requested following any PCS workshops, working sessions, and/or related submittal reviews.
   b. As needed or requested during the course of programming, start-up and testing to reflect all refinements and changes that occur due to specific operational needs and the characteristics of specific equipment and systems supplied under this Contract.
   c. Show all revisions in 'track change' mode.
   d. Change Specification Section Title to read "Process Control Descriptions - Contractor Record Document."
   e. Reference all changes by Request for Information (RFI) number or Change Proposal Request (CPR) number.
2. Submit the revised and updated file as a final Process Control description Record Document in the Operation and Maintenance Manual described in Specification Section 01 78 23.
   a. Provide both paper copy and as Electronic Documents (in portable document format, PDF files) by Electronic Means [in accordance with Section 01 31 26 – Electronic Communication Protocols] of the Record Document process control descriptions in the Operation and Maintenance Manual described in Specification Section 01 78 23.

B. Coordination with vendor-furnished control packages

1. Where vendor packages are supplied as part of the Contract, the vendor packages that are supplied with PLC-based controls shall be programmed by the respective vendors. Provide all programming as required to integrate Vendor-furnished controls into the PCS as described in the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 CONTROL SCREEN DEVELOPMENT

A. Provide two working sessions with Client to review proposed screen graphics. Each working session shall be two hours. Include HDR controls designer in each of the working sessions.

1. Preliminary working session. Contractor shall provide preliminary screen layout for the facility control system, ready for review and discussion with the Client.
2. At a minimum, screens shall:
   a. Be based on the P&IDs provided in the contract documents.

b. Equipment and/or device status displayed visually on screen without having to click on device. For motors, colors might indicate running, off, lead/lag/lag-lag, etc.
c. Include ability to click on controlled equipment or devices and pop-ups provide the ability to adjust equipment operation. I.e. Motor change from Hand/Off/Auto, motor start/stop.
d. Include ability to click on monitored devices in order to change set-points.

3. Pump control:
   a. In MANUAL/HAND mode, settings are accessible to be modified.
   b. In AUTO mode, manipulated settings are not visible.
4. Final working session. Contractor shall provide updated screen layouts based on preliminary working session, and any additional coordination with client during the screen development process.

B. Minimum screens to be developed:
   1. Facility Overview
   2. Electrical Building
   3. Pumping Plant
   4. High lift system
   5. Low lift system
   6. Remote site – Wheatgrass 7
   7. Remote site – Bannock Canal weir
   8. Lube Oil system

C. Control screens shall have a minimum of two-level access for modification of the control screens.
   1. Operator Access: This allows site operators to adjust system settings, set points, etc.
   2. Control System Access: This allows modifications to the system configuration, programming etc. This access is password protected.

D. After the Final working session, and all Client comments have been addressed, submit proposed screens for approval.

E. Refer to Appendix A for List of set points, monitoring requirements, operational guidance, etc.

END OF SECTION

[EXAMPLE - BOOSTER PUMPS]
PROCESS CONTROL DESCRIPTION

Project: [*XXXXX*]
Process Areas: [*Booster Pump Station*]

A.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:

1. Y-602 to Y-606.

A.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:

1. Main Control Panel.
2. Remote HMI(s) located in pump building.
3. High-lift pump P-04 and associated VFD.
4. High-lift pump P-05 and associated VFD.
5. High-lift pump P-06 and associated VFD.
6. Low-lift pump P-01 and associated VFD
7. Low-lift pump P-02 and associated VFD.
8. Low-lift pump P-03 and associated VFD.

B. Major Field Instrumentation:

1. LIT-100A/B: Water intake level transmitters.
2. PIT-10X: Pump discharge pressure transmitter.
3. FIT-10X: Pump discharge flow meter.
4. PIT-200: Wheatgrass 7 pressure transmitter.
5. LIT-300: Irrigation canal level transmitter.

A.3 OVERVIEW DESCRIPTION

A. These pumps will be utilized to supply irrigation water to the surrounding area.

A.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Pumps may be automatically or manually controlled via selections made at the Main Control Panel (MCP), VFD, and Remote OIT in the pumping plant. The PLC shall track the operating speed of the motor and operating speed shall be matched for a bump-less transition from automatic mode to manual mode, or vice versa, as to not interrupt overall plant operation. When placed in the Auto control mode at the Main Control Panel, pumps are controlled by PLC control logic as follows:

1. The high-lift pumps will be controlled by VFDs based on pressure at the remote Wheatgrass 7 Booster pump surge tower. Pressure in the surge tower will be controlled to 13PSI by the 3 high-lift booster pumps. When pressure decreases at the Wheatgrass 7 surge tower, the lead high-lift pump will start at the motors minimum operating speed. If pressure continues to decrease, the VFD will increase pump speed until pressure stabilizes or until the speed setpoint reaches 100%. If the lead pump reaches 100% speed and the pressure continues to decrease, then the lead pump will decrease speed to the minimum operating speed and the lag pump will be started at minimum operating speed. Both pumps will then increase speed until pressure stabilizes or 100% speed is reached by both pumps. If a third pump is required, the two running pumps would reduce speed to minimum operation speed while the lag-lag pump is started. All three pumps will then increase speed until pressure stabilizes or all three pumps reach 100% speed. If pressure increases above 13 PSI, the running pumps will decrease speed until they reach the minimum operating speed. When the running pumps reach minimum operating speed, one of the running pumps will shut off and the remaining running pumps will increase speed to

100%. This process will continue until the pressure is stabilized at 13 PSI or all pumps are off. A deadband of ±0.5 PSI will be applied to the setpoint of 13 PSI to allow for small fluctuations in the pressure at Wheatgrass 7. When a pump shuts off, it will remain off for a minimum of 2 minutes to reduce short cycling of the pump motor. Lead, Lag and Lag-Lag pump designation shall be based upon individual pump run time. The lead pump shall be the pump with the fewest amount of run time hours and the lag-lag pump shall have the most run time hours. Operators shall be able to manually set which pump will operate in the lead, lag or lag-lag position. Operator input shall override the automatic position of the pump.

2. Low-lift pump control will be based on desired flow in the irrigation canal. Operators will input the desired flow rate, and the low-lift pumps will turn on and increase speed until desired flow is reached. The pump start-up process will be same as the high-lift pumps but will be based on flow rate at the weir. Flow at the weir will be determined by using the known weir design and water level input from the level bubbler, FIT-300. Lead, Lag and Lag-Lag pump designation shall be based upon operator input.

B. Pumps can also be controlled manually at the MCP, at the VFD panel, or at the Remote OIT in the pumping plant:

1. When the HOA switch on the VFD is in Auto mode, an operator can select manual mode at the MCP or the redundant OIT in the pumping plant. Manual mode will allow an operator to input the desired speed of a pump and then manually start the pump from either HMI screen. The pump will run at the speed input by the operator until the pump is stopped at the MCP.
2. Each pump can also be controlled manually at the VFD panel by placing the HOA in HAND. Pump speed can be set via a potentiometer or control keypad at the VFD and the pump can be started or stopped via the pushbuttons on the VFD panel.
3. PLC logic utilizes a 2-minute time delay (adjustable) prior to commanding an additional pump to start following the start of the previous pump.

A.5 RESPONSE TO INSTRUMENT OR EQUIPMENT FAILURES

A. All PLC outputs related to pump operation (both speed control and run/stop commands) remain in the last state in the event of the following condition:

1. Loss of communication between the MCP and the controlling instrumentation.
   a. For loss of Wheatgrass 7 Booster Pump Head Pressure signal or the Low-Lift Weir Level signal, Pumps shall not be allowed to run in Auto mode. Pumps shall be permitted to run in Manual mode.

A.6 DISPLAYS AT HMI/OIT

A. Indications and alarms:

1. Forebay Water Level: LIT-100A
2. Forebay Water Level: LIT-100B
3. Forebay Water Level Low Alarm: LIT-100A and/or LIT-100B
4. High Lift Pump P-04 Running: YI-04
5. High Lift Pump P-04 Fault: XA-04
6. High Lift Pump P-04 Motor Speed: SC-04
7. High Lift Pump P-04 High Vibration: VSH-04
8. High Lift Pump P-04 Upper Bearing Temperature: TE-04A
9. High Lift Pump P-04 Lower Bearing Temperature: TE-04B
10. High Lift Pump P-04 Upper Bearing Temperature: TE-04A
11. High Lift Pump P-04 Lube Oil Controller Fault Alarm: XR-40

12. High Lift Pump P-04 Lube Oil Controller Fault Alarm: LAL-40
13. High Lift Pump P-04 Discharge Pressure: PIT-104
14. High Lift Pump P-04 Discharge Flow: FIT-104
15. High Lift Pump P-05 Running: YI-05
16. High Lift Pump P-05 Fault: XA-05
17. High Lift Pump P-05 Motor Speed: SC-05
18. High Lift Pump P-05 High Vibration: VSH-05
19. High Lift Pump P-05 Upper Bearing Temperature: TE-05A
20. High Lift Pump P-05 Lower Bearing Temperature: TE-05B
21. High Lift Pump P-05 Upper Bearing Temperature: TE-05A
22. High Lift Pump P-04 Lube Oil Controller Fault Alarm: XR-50
23. High Lift Pump P-04 Lube Oil Controller Fault Alarm: LAL-50
24. High Lift Pump P-05 Discharge Pressure: PIT-105
25. High Lift Pump P-05 Discharge Flow: FIT-105
26. High Lift Pump P-06 Running: YI-06
27. High Lift Pump P-06 Fault: XA-06
28. High Lift Pump P-06 Motor Speed: SC-06
29. High Lift Pump P-06 High Vibration: VSH-06
30. High Lift Pump P-06 Upper Bearing Temperature: TE-06A
31. High Lift Pump P-06 Lower Bearing Temperature: TE-06B
32. High Lift Pump P-06 Upper Bearing Temperature: TE-06A
33. High Lift Pump P-04 Lube Oil Controller Fault Alarm: XR-60
34. High Lift Pump P-04 Lube Oil Controller Fault Alarm: LAL-60
35. High Lift Pump P-06 Discharge Pressure: PIT-106
36. High Lift Pump P-06 Discharge Flow: FIT-106
37. Low Lift Pump P-01 Running: YI-01
38. Low Lift Pump P-01 Fault: XA-01
39. Low Lift Pump P-01 Motor Speed: SC-01
40. Low Lift Pump P-01 High Vibration: VSH-01
41. Low Lift Pump P-01 Upper Bearing Temperature: TE-01A
42. Low Lift Pump P-01 Lower Bearing Temperature: TE-01B
43. Low Lift Pump P-01 Upper Bearing Temperature: TE-01A
44. High Lift Pump P-04 Lube Oil Controller Fault Alarm: XR-10
45. High Lift Pump P-04 Lube Oil Controller Fault Alarm: LAL-10
46. Low Lift Pump P-01 Discharge Pressure: PIT-101
47. Low Lift Pump P-01 Discharge Flow: FIT-101
48. Low Lift Pump P-02 Running: YI-02
49. Low Lift Pump P-02 Fault: XA-02
50. Low Lift Pump P-02 Motor Speed: SC-02
51. Low Lift Pump P-02 High Vibration: VSH-02
52. Low Lift Pump P-02 Upper Bearing Temperature: TE-02A
53. Low Lift Pump P-02 Lower Bearing Temperature: TE-02B
54. Low Lift Pump P-02 Upper Bearing Temperature: TE-02A
55. High Lift Pump P-04 Lube Oil Controller Fault Alarm: XR-20
56. High Lift Pump P-04 Lube Oil Controller Fault Alarm: LAL-20
57. Low Lift Pump P-02 Discharge Pressure: PIT-102

58. Low Lift Pump P-02 Discharge Flow: FIT-102
59. Low Lift Pump P-03 Running: YI-03
60. Low Lift Pump P-03 Fault: XA-03
61. Low Lift Pump P-03 Motor Speed: SC-03
62. Low Lift Pump P-03 High Vibration: VSH-03
63. Low Lift Pump P-03 Upper Bearing Temperature: TE-03A
64. Low Lift Pump P-03 Lower Bearing Temperature: TE-03B
65. Low Lift Pump P-03 Upper Bearing Temperature: TE-03A
66. High Lift Pump P-04 Lube Oil Controller Fault Alarm: XR-30
67. High Lift Pump P-04 Lube Oil Controller Fault Alarm: LAL-30
68. Low Lift Pump P-03 Discharge Pressure: PIT-103
69. Low Lift Pump P-03 Discharge Flow: FIT-103
70. Air Compressor AC-1 Running: XR-1000
71. Lube Oil Control Valve: SOV-2001
72. Lube Oil Pump Supply Tank T-2001 Level: LIT-2003
73. Low Lift Wier Level and Flow: LIT-300
74. Wheatgrass 7 Booster Pump Head Pressure: PIT-200
75.

A.7 REPORT DESCRIPTIONS

A. Provide daily report containing the following:

1. Total volume (MGD) of water pumped by the high-lift pumps.
2. Total volume (MGD) of water pumped by the low-lift pumps.
3.

B. Provide monthly report containing the following:

1. Total run time of each pump.

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APPENDIX B
LUBRICATION OIL SYSTEM
PROCESS CONTROL DESCRIPTION

Project: Bannock Pumping Plant
Process Areas: Lube Oil System

B.1 REFERENCE DOCUMENTS

A. Process & Instrument Diagrams, P&IDs:

1. Y602 to Y605.

B.2 MAJOR EQUIPMENT AND FIELD INSTRUMENTS

A. Major Equipment:

1. Main Control Panel.
2. Remote HMI(s) located in pump building.
3. P-2000: Lubrication Oil Pump
4. High-lift pump P-04 and associated VFD.
5. High-lift pump P-05 and associated VFD.
6. High-lift pump P-06 and associated VFD.
7. Low-lift pump P-01 and associated VFD
8. Low-lift pump P-02 and associated VFD.
9. Low-lift pump P-03 and associated VFD.

B. Major Field Instrumentation:

1. LIT-2003: Lube oil tank level transmitter.
2. SOV-2001: Pump discharge pressure transmitter.

B.3 OVERVIEW DESCRIPTION

A. Diaphragm pump, P-2000, will be operated to maintain level in tank T-2001. Tank T-2001 supplies lubrication oil the individual pump controllers during operation.

B.4 DETAILED PROCESS CONTROL DESCRIPTIONS

A. Pump P-2000 is a diaphragm pump and will operate when air is supplied to the pump. Air supply will be controlled as follows:

1. In a normal state, LIT-2003 will have an active level that is above the low-level alarm and SOV-2001 will vent the diaphragm pump to atmosphere. When the oil level falls below the low-level alarm setpoint, the PLC will activate SOV-2001. When power is applied to SOV-2001, air will be supplied to the pump, pumping lube oil from T-2000 to T-2001. Once oil level in T-2001 reaches the high-level setpoint, the PLC will deactivate SOV-2001, causing P-2000 to stop and internal air to be vented to atmosphere. If the level in T-2001 is below the low-level setpoint, and P-2000 has run for 150 seconds, the PLC will deactivate SOV-2001. The PLC will then alarm operators that T-2000 is empty, and lube oil should be ordered. High and low-lift pumps will continue to be operational until the low-low level setpoint in T-2001 is reached. When the low-low level setpoint is reached, the PLC will not activate SOV-2001 until an operator manually clears the alarm. Once an operator clears the low-low level alarm, the alarm will be by-passed for 150 seconds to allow P-2000 to fill T-2001 above the low-low level setpoint.

SECTION 40 63 43
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Programmable logic controller (PLC) control system(s), including hardware, software, programming, documentation, and training.

B. Related Sections include but are not necessarily limited to:

1. Section 01 75 00 - Checkout and Start-Up Procedures
2. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
3. Section 40 61 13 - Process Control Systems General Requirements.
4. Section 40 67 00 - Control System Equipment Panels and Racks.
5. Section 40 61 96 - Process Control Descriptions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C37.90.2, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
   b. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
2. International Electrotechnical Commission (IEC)
   a. IEC 61131-3 Programmable logic controllers
3. National Electrical Manufacturers Association (NEMA):
   a. ICS 1, Industrial Control and Systems General Requirements.

B. Qualifications:

1. Installation supervisor shall have had experience in overseeing installation and startup of at least three similar installations within the last five years.
2. Programmer(s) shall have had experience in programming PLCs for at least two projects of similar size and complexity.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 61 13.
2. Product technical data including:
   a. Submit annotated copies of complete PLC software programs:
      1) In native-format file including all applicable formats (ladder logic, function block diagram, sequential function chart, instruction list, structured text).
      2) In PDF-format file with fully annotated PLC code that can be read without the native configuration and programming environment on electronic media (DVD or USB drive).
      3) Provide text description completely defining each unique function block used in the program if FBDs are used.
      4) Provide list of all addresses referenced in logic diagram with description of data associated with each address (Tag database).
   b. Results of factory testing or simulation procedures.

c. Bill of material
d. Drawings containing the following information to be submitted as part of Specification Section 40 67 00 (control panels) submittals:
    1) Arrangement drawings for PLC system components.
    2) Panel and enclosure plans, sections and details.
    3) Access opening locations and required clearances for each panel and enclosure.
    4) Enclosure internal wiring and terminal blocks.
e. DIP Switch and Jumper Settings, if applicable.
f. I/O Rack and I/O Module Layout.
g. Wiring and Interconnection diagrams.
    1) Power Supplies.
    2) I/O Points.
    3) Communications.
h. Catalog cut sheets containing information on PLC components to be submitted as part of these Specification Section submittals.

3. Certifications:
    a. Qualifications of installation supervisor.
    b. Qualifications of programmer(s).
4. Software Licenses:
    a. Documentation of all software package licenses being assigned to Owner.
5. Manufacturer support proposal agreement.

B. Operation and Maintenance Data:
1. See Specification Section 01 78 23 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. Program Documentation.
    a. Program Overview.
    b. Program Listing.
    c. I/O Listing.
    d. Memory Map.
    e. I/O Cross Reference.
3. Maintenance procedures.
    a. Include the location and phone numbers of service centers (including 24 hour "hot lines").
    b. Provide specific information including operation and maintenance requirements, programming assistance, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Rockwell Automation: Allen-Bradley.
2. Emerson: Rx3i
3. Schneider Electric: Modicon.
4. Siemens: SIMATIC.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Specification Section 40 61 13.

B. The PLC system shall meet the control requirements of the Section 40 61 96 - Process Control Descriptions, Drawings, and Specifications.

C. PLC programming shall be documented and factory tested.

D. The PLC system be capable of operating in ambient conditions of 32 to 140 degrees F temperatures and 5 to 95% relative humidity without the need for purging or air conditioning.

E. Environmental Controls:

1. Furnish circulation fans in solid state control system enclosures.
2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
3. Air conditioning applications shall include means of preventing moisture condensation.

F. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be designed so that the failure of any one component does not affect equipment on all trains. The following shall also apply.

1. I/O modules shall be segregated on a train basis unless required for safety reasons.
2. Where several equipment units operate in parallel, but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common header), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one I/O module will not affect the other parallel unit/s.

2.3 HARDWARE

A. Processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.

B. Redundant processors, if specified, shall have seamless fail-over capability.

C. I/O modules shall be capable of being replaced while the PLC is on-line and operating.

D. All I/O modules shall have terminal block failure or removal monitoring.

E. Analog output modules shall have a resolution of at least 12 bits.

F. Electrical isolation shall be provided between logical and field device.

G. I/O Module field wiring shall remain undisturbed when removing or replacing an I/O module.

H. Fail-safe state for each I/O channel shall be capable of being defined as on, off or fail-in-place.

I. Power Supply Units:

a. Electrical service to PLC system shall be 120 VAC, 60 Hz.

J. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

K. Incorporate the following minimum safety measures:

1. Watchdog function to monitor:
   a. Internal processor clock failure.
   b. Processor memory failure.
   c. Loss of communication between processor and I/O modules.
   d. Processor ceases to execute logic program.
2. Safety function wiring: Emergency safety switches shall not be wired into the controller.

3. Safe wiring:
    a. Unless otherwise specified, activation of alarms and stopping of equipment shall be based on de-energization of rather than the energization of control circuits.
4. Initial safety conditions:
    a. Utilize program module to dictate output states in a known and safe manner prior to running of control program.
    b. Utilize program each time PLC is initialized/re-initiated and the control program activated.
5. Monitoring of internal faults and display:
    a. Internal PLC system status and faults shall be monitored and displayed.
        1) Monitored items shall include:
            a) Memory ok/loss of memory.
            b) Processor ok/fault.
            c) Scan time overrun.
6. Control of programs: Protect access to PLC program loading with password protection or with locked, key operated selector switches.
    a. Provide login, passwords, and/or keys to Owner at Substantial Completion.
    b.
7. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
8. Operator intervention:
    a. Logic system failure shall not preclude proper operator intervention.
    b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.4 SOFTWARE

A. All software will be furnished and licensed to Owner.
    1. At Substantial Completion, transfer all licenses and media to Owner.
    2. At Substantial Completion, all software must be latest edition and licensed to the Owner.
    3. Software shall be lifetime licensed and be OEM supported for at least 10 years from date of license transfer.

B. Programming.
    1. Languages supported: All application programming in IEC 61131-3 compliant language.
    2. Program PLC utilizing ladder diagram, function block, or structured text format.
    3. Protect program via removable key switch or password to prevent unauthorized changes. Provide password and/or programming keys to Owner.
    4. Capable of on-line and off-line programming.

C. PLC program Structure.
    1. Clear, concise, well-annotated logic.
    2. Implement a modular design to allow specific functions to be replicated to ensure consistency.
    3. Program shall align with the control strategies. Include comments reflecting alignment with control strategies.
    4. Include named variables that reflect the actual use of the variable.
    5. Annotate program listing to include the following (using the features of the appropriate PLC programming software):
        a. Clearly identified variables, I/O points, contacts, and analog values.

b. Written description of each functional area.
c. Written description of each rung's function.
d. Reference to control loop number for each rung where applicable.
e. Reference to instrumentation tag number of I/O devices for each rung where applicable.

D. Manufacturer support

1. Submit a written proposal for a manufacturer support agreement for all products specified herein for a minimum of 12 months starting at final completion of the project. The cost of this manufacturer support agreement shall not be included in the Contract Price. The support agreement shall be executed in the name of, and for the benefit of, the Owner. At a minimum, this agreement shall provide the Owner with:
   a. 8 AM to 5 PM, 5 day per week manufacturer telephone support.
   b. Access to the manufacturer's technical support website.
   c. Software updates and patches.

2.5 COMPONENTS

A. PLC System Central Processor Unit (CPU):

1. The PLC shall have the capability of communicating with other commonly specified PLC and control system protocols such as Modbus/RTU, Modbus/TCP, Profibus, Ethernet/TCP and OPC.
2. CPU shall include capability to modify logic via an Ethernet port without taking processor off line.
3. Memory:
   a. Battery-backed RAM.
   b. Non-volatile program storage via flash EEPROM:
      1) Automatically download to RAM in the event RAM is corrupted.
4. Memory battery backup shall be capable of 180 days memory retention with fresh battery.
   a. Provide visual indication of battery status and alarm low battery voltage.
   b. Memory battery backup shall be capable of 28 days memory retention after the "Battery Low" indicating LED is on.
5. Plug-in card designed to allow quick field replacement of faulty devices.
   a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
6. 20% minimum spare useable memory capacity after all required programming is in place and operating.
7. Capable of executing all control functions required by the Specifications and Drawings.
8. Built-in three-mode (proportional-integral-derivative) control capabilities.
   a. As directly selectable algorithms requiring no user knowledge of programming languages.
9. Lighted status indicators for "RUN" and "FAILURE".
10. Capable of manual or automatic control mode transfer from the operating console stations or from within the control strategy.
    a. Transfer shall be bumpless and balanceless.

B. Input/output (I/O) Modules:

1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
   a. I/O solid state boards with status lights indicating I/O status.
   b. Electric isolation between logic and field device.

c. Capability of withstanding low energy common mode transient to 1000 V without failure.
d. Incorporate noise suppression design.
e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
g. Install 20% spare I/O points for each type.

3. Input/output connection requirements:
   a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
   b. Prewire I/O modules to terminal blocks.
   c. Provide terminal blocks with continuous marking strip.
   d. Size terminals to accommodate all active data base points and spares.
   e. Provide terminals for individual termination of each signal shield.
   f. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete I/O modules:
   a. Interface to ON/OFF devices.
   b. I/O status indicator on module front.
   c. Voltage rating to match circuit voltage.
   d. Output module current rating:
      1) Match maximum circuit current draw.
      2) Minimum 1.0 continuous A/point for 120 VAC applications.
   e. Isolated modules for applications where one module interfaces with devices utilizing different sources of power.
5. Discrete outputs shall be fused:
   a. Provide one fuse per common or per isolated output.
   b. Provide blown fuse indication.
   c. External fusing shall be provided if output module does not possess internal fusing.
   d. Fuses provided external to output model shall:
      1) Be in accordance with module manufacturer's specifications.
      2) Be installed at terminal block.
6. Analog I/O modules:
   a. Input modules to accept signals indicated on Drawings or Specifications.
   b. Minimum 12 bit resolution.
   c. I/O chassis supplied power for powering connected field devices.
   d. Differential inputs and outputs.
   e. User configurable for desired fault-response state.
   f. Provide output signals as indicated on Drawings and Specifications.
   g. Individual D/A converter for each output module.
   h. Individual A/D converter for each input module.
7. Communications Modules:
   a. Provide communications modules as-shown on Drawings.
   b. Provide communications modules for each protocol required for a complete communications system as shown on drawings.
   c. Multi-port Ethernet modules may not be utilized as a network switch or to bridge networks.
   d. [Separate communications modules and networks are required for I/O devices and PLC to HMI communications].

C. Power Supply Units:

1. Provide regulated power units:
   a. Designed to operate with PLC system and shall provide power to:
      1) All components of PLC system.
      2) All two-wire field instruments.
      3) Other devices as indicated on Drawings or Specifications.
   b. Capable of supplying PLC system when all of the specified spare capacity is utilized.
   c. Each power supply shall be sized such that it will carry no more than 75% of capacity under normal loads.
2. Electrical service to PLC system is 120 VAC, 60 Hz.
3. Separate AC circuit breakers shall be provided for each power supply.
4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
5. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
6. Power distribution:
   a. Immune to transients and surges resultant from noisy environment.
   b. Shall provide constant voltage level DC distribution to all devices.
7. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 5minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
   a. UPS powered loads:
      1) All rack mounted PLC components.
      2) Local operator consoles.
      3) All power supplies furnished with the PLC and associated loads.
   b. Input:
      1) 108 to 132 VAC.
      2) 57 to 63 Hz.
      3) Line fuse protection.
   c. Output:
      1) 120 VAC nominal.
      2) 60 Hz.
      3) Short circuit protected.
      4) Instantaneous transfer time.
   d. IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.
   e. Battery: Maintenance free lead acid.

D. PLC System Enclosure:

1. In accordance with Specification Section 40 67 00 - Control Panels.
2. Component placement:
   a. Mount all controller components vertically within the enclosure to allow maximum convection cooling.
   b. Either install power supplies above all other equipment with at least 10 inches of clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
   c. Do not place I/O racks directly above the CPU or power supply.

d. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
e. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 inches of separation between the magnetic area and the control area.
f. Place circulating fans close to major heat generating devices.
g. Segregate input/output modules into groups of identical type.

3. Wiring and grounding to be in accordance with Specification Section 40 67 00.
4. Termination requirements:
   a. In accordance with Specification Section 40 67 00.
   b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
   c. Prewire I/O modules to terminal blocks.
   d. Size terminals to accommodate all active database points and spares.
   e. Provide terminals for individual termination of each signal shield.
   f. Field wiring shall not be disturbed when removing or replacing an I/O module.

E. PLC System Software and Programming:

1. Provide all hardware and programming required to provide communication between the PLC and the human-machine interface.
2. Coordinate with HMI programmer to allow modification of all setpoint through the HMI utilizing appropriate security considerations. Configure scaling and setpoint validation within PLC logic.
3. All communications logic shall include a watch-dog timer and alarm for loss of communications. Coordinate communications failure response with Owner.
4. Provide programming to accomplish all control and monitoring requirements of the Drawings and Specifications.
5. Full documentation capability.
6. Online and offline programming.
7. Offline simulation prior to download.
8. Program over network capability.
9. Two-step commands requiring PLC programmer verification prior to modification of any programming.

2.6 ACCESSORIES

A. Provide all accessories required to install and test a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

B. Provide all programming cables required to configure the PLC logic.

2.7 SOURCE QUALITY CONTROL

A. Perform Factory Acceptance Testing in accordance with Specification Section 40 61 21 - Process Control System Testing.

2.8 MAINTENANCE MATERIALS

A. Furnish Owner with the following extra spares:

1. One spare CPU for every four field CPUs or fraction thereof installed.
2. One spare communication module by type installed in the Plant.
3. One spare I/O card of each card type for every 10 cards or fraction thereof installed.
4. One spare power supply for every 10 power supplies or fraction thereof installed.

5. A set of spare fuses for all installed types.

B. Include a complete bill of materials itemizing each line item with make and model (part) number.

C. Include a complete set of all special tools required to install, maintain and test the PLCs.

PART 3 - EXECUTION

3.1 FUNCTIONALITY

A. Complete System.

1. Provide all graphics and logic programming, configuration, coordination, integration, and testing required for furnishing a fully functioning system.
2. Provide interface support with all foreign device interfaces (FDI) communicating with the PLC system.

3.2 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Test system in accordance with Specification Section 40 61 21 - Process Control System Testing.

B. Demonstrate system in accordance with Specification Section 01 75 00 - Checkout and Start-Up Procedures.

3.4 TRAINING

A. Employee of the manufacturer or certified representative to provide one week of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.

B. As a minimum, training shall cover:

1. Hardware overview.
2. Software overview.
3. Documentation.
4. Maintenance.
5. Trouble shooting.
6. Operation, e.g., changing set points, passwords, etc.

3.5 DOCUMENTATION

A. Update O&M manuals to reflect as-built conditions.

3.6 SUPPORT

A. Provide on-call technical support for a period of one year after substantial completion. Include a minimum of two site visits to work with Owner on any final modifications to the logic.

END OF SECTION

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SECTION 40 66 40
TELEMETRY SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Items required include but are not necessarily limited to the following:
   a. Radios.
   b. RTUs (Remote Terminal Units).
   c. Wireless I/O.
   d. Cellular-Based RTUs.
   e. Antennas, Towers and Masts.
   f. Transmission Cable and Miscellaneous.

B. Related Sections include but are not necessarily limited to:

1. Section 10 14 00 - Identification Devices.
2. Section 40 61 13 – Process Control Systems General Provisions.
3. Section 40 61 96 - Control Loop Descriptions.
4. Section 40 67 00 - Control Systems Equipment Panels and Racks.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Federal Communications Commission (FCC):
   a. 47 CFR 15 - Radio Frequency Devices, Section 15.247 - Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.
2. International Electrotechnical Commission (IEC):
   a. 61131-3 - Programmable Controllers, Part 3: Programming Languages.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 802.3, Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
   a. 222-H, Structural Standards for Steel Antenna Towers and Antenna Supporting Structures.
5. Underwriters Laboratories, Inc. (UL):
   a. 508A, Standard for Safety Industrial Control Panels.

B. Qualifications.

1. Radio Study/Survey Staff or Subcontractor:
   a. Experience:
      1) Has satisfactorily provided a radio study/survey report for a minimum of five projects of similar magnitude and function.

1.3 DEFINITIONS

A. ARQ (Automatic Resend Query): Method of error correction where the receiver initiates an order to retransmit data blocks that are determined to be corrupted in transmission.

B. BER (Bit Error Rate):

1. Ratio of the number of bits received in error to the total number of bits transmitted.
2. Used as a measure of quality for data links.

C. CRC (Cyclic Redundancy Check):

1. A method utilized for detecting errors in data transmission or storage.
2. A number is calculated on the originating end based on the message contents, and then appended to the message before transmission.
3. The CRC is re-calculated on the receiving end, and compared to the previously calculated value.
4. A match of the two calculated values indicates a high probability that the message was received correctly.

D. Omnidirectional Antenna: An antenna that radiates maximum power uniformly 360 degrees in the horizontal plane.

E. RTU (Remote Terminal Unit):

1. A remotely located device that collects data, codes the data into a format that is transmittable and transmits the data back to a central Supervisory Control and Data Acquisition (SCADA) system.
2. The RTU also receives communication from the SCADA system and implements processes as directed.

F. Spread Spectrum:

1. Communications technique whereby a radio frequency signal is spread (modulated) in order to generate an expanded bandwidth signal.
   a. Frequency Hopping Spread Spectrum: Communications technique where the frequency of the radio signal repeatedly “hops” from one Frequency to another in accordance with a random but predictable sequence.
   b. Direct Sequence Spread Spectrum: Communications technique whereby the stream of information (data signal) is combined with a higher data-rate bit sequence, or chipping code, that divides the user data according to a spreading ratio.

G. Yagi Antenna:

1. A uni-directional radio antenna, consisting of a driven element, a reflector, and one or more directors.
2. The antenna is primarily used for frequencies above 10 MHz and are used only in point-to-point applications.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 61 13.
2. Product technical data:
   a. Annotated hard copies of RTU software programs.
      1) Annotate program listing to include the following (as applicable):
         a) Descriptive titles for all subroutine functions.
         b) Reference to control loop numbers.
         c) Reference to instrumentation and equipment tag numbers.
      2) Define all function blocks used in program.
      3) Provide listing of all addresses referenced in logic diagram with description of data associated with each address.
   b. Arrangement drawings for RTU system components in accordance with Specification Section 40 67 00.

c. Panel and enclosure plans, sections and details in accordance with Specification Section 40 67 00.
d. Enclosure internal wiring and terminal blocks in accordance with Specification Section 40 67 00.
e. Manufacturer's installation instructions.
3. Submit all catalog cut sheets under Specification Section 40 66 40 submittals.
4. Submit all panel fabrication drawings and associated wiring diagrams for RTUs under Specification Section 40 67 00 submittals.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Clear listing of all passwords required to edit, modify, or view programming and configuration.
2. Radio Study/Survey Staff/Subcontractor Qualification Verification (upon request):
3. Radio site survey results including the following minimum information:
a. Electromagnetic noise level at each site.
b. Data rate for each radio.
c. Received radio signal strength at installed antenna height for each radio.
d. Fade margin in dB (difference between weakest signal the radio can read and actual received signal strength).
e. Spectrum analysis.
4. List of all recommended spares for maintenance purposes with each item separately priced.
a. List shall include all special tools and test equipment necessary for the maintenance of the complete system.
5. Results of factory testing procedures.

D. Field Quality Control.
1. Items listed under Part 3, 3.2 of this specification section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 CELLULAR-BASED RTU'S

A. Manufacturers:
1. Mission Communications MyDro 150.
2. Red Lion Sixnet RAM 6000.
3. Honeywell RTU2020.
4. Tosibox 670

B. Design and Fabrication:
1. Transmission of data:
a. Type: Cellular service provider.
1) 4G communication.
2. RTU asset monitoring service:

a. Update times:
   1) Analog input data snapshots at intervals such as 1, 5 or 10 minutes to be configurable for transmission.
      a) Significant changes to be transmitted to the cellular service within 2 seconds of the change.
   2) Discrete input changes-of-state to be reported to the monitoring service upon detection.
b. Data logging capabilities to include time of day and number of occurrences of discrete input changes such as such as pump starts and stops and operator site visits.
   1) Examples of analog data logging and reporting to include, high and low values of analog inputs and time of day they occurred.
c. Monitoring service shall provide a paging and phone call feature to notify selected personnel of alarm situations.
   1) The service shall allow for a rotational schedule of phone/pager numbers to be called and shall be configurable from the web site.
d. Data communication to the Client's SCADA system via private socket connections.
e. .

3. Antenna and flexible coaxial cable shall be provided with the RTU.
   a. An option of ordering a longer run of antenna cable and a higher gain antenna with the RTU shall be available.

2.3 ANTENNAS, TOWERS AND MASTS

A. Design and Fabrication:

1. All steel antenna towers and supporting structures shall be in accordance with TIA/EIA/ANSI 222-H.
2. Type:
   a. Yagi antenna for point-to-point applications.
   b. Omnidirectional antenna for point-to-multipoint or multipoint-to-multipoint applications.
3. Lightning protected: Mast or tower direct connected to ground.
4. Provide antenna surge suppressor and connect to coaxial cable in cabinet housing radio, per manufacturer recommendations.
5. Materials:
   a. Antenna:
      1) Aluminum or aluminum with Teflon impregnated powder coat finish.
      2) .
   b. Mounting hardware:
      1) 316 stainless steel or aluminum.
   c. Towers and masts:
      1) Aluminum.
6. Retain services of a licensed Professional Engineer in the State of Idahoto design radio tower structural members and foundation.
7. Tower design shall address:
   a. Geotechnical conditions. Procure the services of a geotechnical engineer if necessary.
   b. Site conditions.
   c. Dynamic loading, including wind loads.
   d. Dead loading.
   e. Ancillary loads from equipment on tower.
8. Tower shall be self-supporting without guide wires.

9. Height of the tower shall be as required based on results of radio-pathway survey. Contractor shall submit results of the radio path study to the Engineer and Owner for approval of tower height. Minimum tower height shall be as listed in the schedule provided herein. If a modification to the listed tower height is deemed necessary, the Contractor shall submit for approval to the Engineer and Owner before procurement and installation.
10. Steel towers shall be galvanized to prevent rust and corrosion.
11. Provide foundation(s) adequate for the tower(s) and/or mast(s) including any specified future expansion.
12. Provide all masts, supports, lightning suppressors, and other apparatus required to make a complete and operable radio telemetry system.
13. Schedule:

APPLICATION	ANTENNA HEIGHT (FT ABOVE GRADE)	TOWER/MAST TYPE	ANTENNA TYPE	ANTENNA GAIN	

2.4 TRANSMISSION CABLE AND MISCELLANEOUS

A. Cable Manufacturers:
   1. Andrew Corp. LDF Series.
   2. Times Microwave Systems LMR Series.

B. Provide low-loss foam-dielectric type cable connecting radio antenna port(s) with the antenna.
   1. Cable: 1/2 inches or larger diameter as required to prevent signal losses in cable from degrading performance.
   2. Weatherproof, suitable for direct environmental exposure.
      a. Use "O" ring seals on connections.

C. Provide "superflexible" transmission cable (length as required) at the radio antenna port.
   1. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.

D. Provide grounding connections to the antenna mast and cable in accordance with manufacturer’s recommendations.

2.5 ACCESSORIES

A. Provide all accessories required to furnish a complete telemetry system to accomplish the requirements of the Drawings and Specifications.

B. Security Controls:
   1. Provide all control panels and enclosures with door switch monitored by discrete input utilizing normally closed contacts.
   2. Configure door switch as an event at the HMI.

2.6 SOURCE QUALITY CONTROL

A. Provide a performance test after factory completion and prior to shipment.
   1. Conduct a test where the RTU is operated continuously and checked for correct operation.
   2. Conduct testing with dummy I/O’s to verify each control loop operation.
   3. Allow for Owner and Engineer representatives to witness testing program.
      a. Provide minimum of 15 days notice prior to testing.
   4. Do not ship prior to successful completion of this testing program.

2.7 MAINTENANCE MATERIALS

A. Furnish Owner with the following extra materials:

1. One spare I/O card of each card type for every 10 cards or fraction thereof installed.
2. One spare RTU of each type installed.
3. One spare power supply of each type for every 10 power supplies or fraction thereof installed.
4. One spare radio of each type installed.
5. One spare surge arrestor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install telemetry system as shown on Drawings in accordance with manufacturer's written instruction.

B. Provide documentation verifying the data communication rate (actual throughput), signal strength and signal quality for each radio.

3.2 FIELD QUALITY CONTROL

A. Conduct startup of equipment and perform operational checks.

B. Maintain and submit an accurate daily or weekly log of all commissioning and startup functions.

1. All commissioning/startup functions may be witnessed by the Engineer.
2. All reports shall be signed and dated by the Contractor.

C. Provide Owner with a written statement that equipment has been installed properly, started up, and is ready for operation by Owner’s personnel.

3.3 DEMONSTRATION

A. Demonstrate system in accordance with Specification Section 01 75 00 and 40 61 13.

3.4 TRAINING

A. On-site Training:

1. Provide certified manufacturer’s representative to provide one half day of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.
   a. As a minimum, training shall cover:
      1) Hardware overview.
      2) Software overview.
      3) Maintenance.
      4) Troubleshooting.
         a) How to recover from an RTU failure (i.e. reloading an RTU’s programming from scratch).
      5) Operation, e.g., changing set points, passwords, etc.

B. Sample RTU Points List is given below as a typical example. If I/O points list is included elsewhere, such as in section 40 61 93 - PROCESS CONTROL SYSTEM INPUT-OUTPUT LIST, this article can be left as optional text (deleted).RTU-11, Cedar Creek Well House:

END OF SECTION

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SECTION 40 67 00

CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for control panels and enclosures utilized as follows:
   a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Section 40 66 40, Section 40 71 00, Section 40 72 00, Section 40 73 00, Section 40 63 43, Section 40 78 00, or Section 40 61 43.
   b. This Section is only applicable to panels furnished with equipment specified in other specification divisions when so stated in the applicable equipment specification section.

B. Related Sections include but are not necessarily limited to:

1. Section 10 14 00 - Identification Devices.
2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
3. Section 40 66 40 - Telemetry Systems.
4. Section 40 61 13 - Process Controls Systems General Requirements.
5. Section 40 61 21 - Process Control System Testing.
6. Section 40 61 43 - Surge Protection Devices for Instrumentation and Control Equipment.
7. Section 40 63 43 - Programmable Logic Controllers.
8. Section 40 71 00 - Flow Measurement.
9. Section 40 72 00 - Level Measurement.
10. Section 40 73 00 - Pressure Instrumentation.
11. Section 40 74 00 - Temperature Measurement.
12. Section 40 75 00 - Process Liquid Analytical Measurement.
13. Section 40 78 00 - Panel Mounted Instruments.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. B75, Standard Specification for Seamless Copper Tube.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ICS 4, Industrial Control and Systems: Terminal Blocks.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC):
      1) Article 409, Industrial Control Panels.
      2) Article 504, Intrinsically Safe Systems.
5. Underwriters Laboratories, Inc. (UL):
   a. 508A, Standard for Safety Industrial Control Panels.
   b. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
   c. 913, Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

B. Qualifications:

1. See Section 40 61 13 - Process Control Systems General Requirements.

C. Miscellaneous:

1. Approved supplier of Industrial Control Panels under provisions of UL 508A or UL 698A.
   a. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
   b. Control panel(s) without an affixed UL 508A or UL 698A label shall be rejected and sent back to the Contractor's factory.

1.3 DEFINITIONS

A. Panel: Control panels or enclosures listed in the schedule included in this Specification Section.

B. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.

C. Intrinsically Safe:

1. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
2. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

E. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

F. Instrumentation Cable:

1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad) and is used for the transmission of low current or low voltage signals.

G. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.

H. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.

I. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

J. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC or RTU.

K. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.

L. Highway Addressable Remote Transducer (HART): a bi-directional communication protocol that provides data access between intelligent field instruments and host systems.

M. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.

N. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.

O. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20mA DC analog signals.

1.4 SUBMITTALS

A. See Section 40 61 13.

B. Shop Drawings:

1. Table of contents sheet(s).
2. Legend and abbreviation sheets.
3. Panel exterior layout drawings.
4. Panel interior layout drawings.
5. Wiring diagrams.
6. Communication network drawing(s).
7. Bill of Material for each panel.
8. Panel door weight calculation.
9. Electrical load calculations for each panel.
10. Climate control calculations for each panel.

C. Product Data:

1. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

D. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

E. Informational Submittals:

1. Unwitnessed Factory Testing confirmation of completion.
2. Record Drawings:
   a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.
   b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

1.5 SUBMITTAL REQUIREMENTS

A. Shop Drawings:

1. Prepared with computer aided design (CAD) software.
2. Printed on 11 by 17 inches sheets.
3. Drawings shall include a title block containing the following:
   a. Plant or facility name where panel(s) are to be installed.
   b. Drawing title.
   c. Drawing number.
   d. Revision list with revision number and date
   e. Drawing date.
   f. Drawing scale.
   g. Manufacturer name, address, and telephone number.
4. Cover sheet for each drawing set shall indicate the following:
   a. Plant or facility name.
   b. Project name.
   c. Submittal description.
   d. Revision number.

e. Issue date.

5. Table of contents sheet(s) shall indicate the following for each drawing in the set:
   a. Drawing number.
   b. Drawing title.
   c. Sheet number.
6. Legend and abbreviation sheets shall indicate the following:
   a. Description of symbols and abbreviations used.
   b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
   c. Confirmation that the panel(s) are to be affixed with a UL 508A or UL 698A label prior to shipment from the factory.
7. Bill of Material for each panel shall include the following component information:
   a. Instrument tag number.
   b. Quantity.
   c. Functional name or description.
   d. Manufacturer.
   e. Complete model number.
   f. Size or rating.
8. Panel exterior layout drawings to scale and shall indicate the following:
   a. Panel materials of construction, dimensions, and total assembled weight.
      1) All dimensions shall be in inches.
   b. Panel access openings.
   c. Conduit access locations.
      1) Ensure conduit entry locations allow for sufficient bend radius of field cables entering enclosure.
      2) Control panel exterior layout shall identify conduit and cable entry locations.
   d. Front view, side views and top view of enclosure.
   e. Front panel device layout.
   f. Nameplate schedule:
      1) Nameplate location.
      2) Nameplate dimensions.
      3) Legend which indicates text, letter height and color, background color and nameplate material.
      4) Include exterior legends as per UL requirements.
      5) Short Circuit Current Rating (SCCR) marking per NFPA 70 or statement of exception. Include any required calculations.
   g. Alarm annunciator window engraving schedule.
   h. Layouts of graphic panels or mosaic displays.
   i. Include a statement on the drawings that indicates that the panel has been built as per UL508A or UL698A standards.
9. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
   a. Sub-panel or mounting pan dimensions.
      1) All dimensions shall be in inches.
   b. Interior device layouts indicating dimensioned location of devices.
   c. PLC/RTU general arrangement layouts.
   d. Wire-way locations, purpose, and dimensions. Include center line dimensions for all DIN rail and wire-way.
   e. Terminal strip designations.

f. Location of external wiring and/or piping connections.
g. Location of lighting fixtures, switches and receptacles.
h. Include interior legends as per UL requirements.

10. Wiring diagrams shall consist of the following:
    a. Panel power distribution diagrams.
    b. Control and instrumentation wiring diagrams.
    c. PLC/RTU I/O information:
        1) Model number of I/O module.
        2) Description of I/O module type and function.
        3) Rack and slot number.
        4) Terminal number on module.
        5) Point or channel number.
        6) Programmed point addresses.
        7) Signal function and type.
    d. Internal network connections diagram
    e. Wiring diagrams shall identify each wire as it is to be labeled.
    f. Wiring diagrams shall include line/ rung references.
    g. Relay coils and their associated contacts shall be cross referenced to each other and clearly identified on the drawings.
    h. Wires leaving the sheet shall clearly indicate the continuation sheet and line/ rung references.
11. Communication network drawing(s) shall include:
    a. Network equipment
    b. Interconnections between all network equipment within the panel.
    c. Connection to the plant network.

B. Verify that panel door mounted equipment will not exceed the maximum allowed weight as per manufacturer's specification.
    1. Submit panel door weight calculation. Include weight of computer if using a laptop shelf.

C. Electrical load calculations for each panel:
    1. Panel current draw based on connected load.
    2. SSCR Calculations.
    3. UPS Run time calculations.
    4. DC power supply load calculations.
    5. Climate control calculations for each panel.
    6. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.
    7. Submit control panel heat release calculations (Watts or BTU/HR). Verify results with cooling/heating software. Submit heating and/or cooling equipment as required. Refer to Section 2.1.
    8. Provide temperature monitoring switch when an air conditioner is required by heat release calculations. High Temperature switch shall be wired to a PLC discrete input for temperature monitoring.
    9. Provide temperature monitoring switch when heater is required by heat release calculations. Low temperature switch shall be wired to a PLC discrete input for temperature monitoring.
    10. Air conditioners shall have built-in temperature display.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Enclosures:
   a. Hoffman Engineering Co.
   b. Hammond Manufacturing.
   c. Saginaw Control and Engineering.
   d. Rittal
2. Panel heaters:
   a. Hoffman Enclosures, Inc.
   b. Hammond Manufacturing.
   c. Rittal
3. Heat exchangers and air conditioners:
   a. Hoffman Engineering Co.
   b. Hammond Manufacturing.
   c. Saginaw Control and Engineering.
   d. Rittal
   e. Pfannenberg.
   f. Kooltronic
4. Cooling fans and exhaust packages:
   a. Hoffman Enclosures, Inc.
   b. Hammond Manufacturing.
   c. Saginaw Control and Engineering.
   d. Rittal
5. Internal corrosion inhibitors:
   a. Hoffman Enclosures, Inc.; Model A-HCI10E
   b. Northern Technologies International Corporation (NTIC); Model Zerust VC.
   c. Cortec Corporation; Model VpCI Emitting Systems.

2.2 ACCESSORIES

A. Panel Nameplates and Identification:

1. See Section 10 14 00.

B. Free standing enclosures containing a PLC shall be provided with an interior swing out shelf for laptop computers.

C. Enclosures shall be provided with print pocket mounted on the interior of the door. Free standing enclosures shall have a minimum size print pocket of 12 inches.

D. Enclosures containing a PLC shall include door contacts to monitor enclosure door status. Door contacts shall be wired to a PLC input for monitoring status.

E. All field instrument enclosure penetrations shall be plugged using threaded conduit plugs to prevent water or contaminant entry into the enclosure during installation.

1. Instruments shall maintain manufacturer's rating for the appropriate area designation.
2. Tape and/or plastic plugs shall not be an acceptable means of preventing water/contaminate intrusion.

2.3 FABRICATION

A. General:

1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.
3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
    a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
    b. The window shall maintain the required NEMA rating of the enclosure.
4. Externally mounted components including but not limited to air conditioners, enclosed transformers, external disconnect switches and external surge protector boxes shall match the NEMA rating and be constructed of the same material as the control panel. As an illustrative example, a NEMA 3/3R external enclosed transformer shall not be mounted on a NEMA 4X stainless steel panel.
5. Panel(s) shall be completely assembled at the Contractor's factory.
    a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
6. Painting:
    a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
        1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.
        2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
        3) Utilize solvent or chemical methods to clean panel surfaces.
        4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
        5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
        6) Bake powder coating at high temperatures to bond coating to enclosure surface.
            a) Panel interior shall be white with semi-gloss finish.
            b) Panel exterior shall be ANSI #61 gray with flat finish.
        7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.
    b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.
7. Finish opening edges of panel cutouts to smooth and true surface conditions.
    a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
8. Panels shall meet all requirements of UL 508A or UL 698A.
    a. If more than one disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one disconnect switch required to de-energize the equipment before servicing."
9. Provide control panel in accordance with NFPA 70, Article 409.
    a. In the event of any conflict between NFPA 70, Article 409 and UL 508A or UL 698A, the more stringent requirement shall apply.
10. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
    a. Determine the SCCR rating by one of the following methods:
        1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.

2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.

b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.

c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

B. Free-Standing Panels:

1. Welded construction.
2. Completely enclosed, self-supporting, and gasketed, dust-tight.
3. Rolled lip around all sides of enclosure door opening.
4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
5. Full height, fully gasketed flush pan doors.
6. Full length piano hinges rated for 1.5 times door plus instrument weight.
7. Doors with keyed alike locking handles and three-point catch.
8. Appropriate conduit, wiring, and instrument openings shall be provided.
9. Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Wall Mounted Panels:

1. Seams continuously welded and ground smooth.
2. Rolled lip around all sides of enclosure door opening.
3. Gasketed dust tight.
4. [Door clamps and hasp/staple for padlocking] [Three-point latching mechanism operated by oil tight key-locking handle].
5. Key doors alike.
6. Continuous heavy GA hinge pin on doors.
   a. Hinges rated for 1.5 times door plus instrument weight.
7. Front full opening door.
8. Brackets for wall mounting.

D. Internal Panel Wiring:

1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
   a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
   b. Size wire ducts to include a minimum of 20% spare fill capacity.
   c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
   d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Lay out panel wire-duct on both sides of each terminal strip. Leave one wire-duct empty, so the field wiring has sufficient room for entry into the panel through this wire-way. Designate the other wire-duct for panel wiring.
3. Utilize fiber optic and Ethernet cable management accessories within the panel.
   a. Terminate Ethernet cables from the field to RJ45 punch down blocks. Connect Ethernet patch cords from the RJ45 punch down block to the Ethernet switch.
   b. Terminate Fiber optic cable from field in fiber optic patch panel. Terminate all fibers within the cable. Connect Fiber optic patch cords from the fiber optic patch panel to the fiber optic Ethernet switch.

4. Wiring shall be installed such that if wires are removed from one device, source of power will not be disrupted to other devices.
5. “Daisy-chaining” of ground cables or power neutrals between equipment is not permitted.
6. Terminate all internal wiring with no more than two (2) conductors per terminal block point. For terminal strips designated for field wiring, only one side of the terminal strip shall be used for panel wiring.
7. Splicing and tapping of wires permitted only at terminal blocks.
8. Wire bundles to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
    a. Protect bend area with sleeve.
9. Arrange wiring neatly, cut to proper length, with surplus wire removed.
    a. Arrange wiring with sufficient clearance.
    b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.
10. To eliminate noise coupling or interference, AC power and control circuits shall be routed separate from analog signal cables, low voltage control circuits, and communications cables and digital signal cables.
    a. Separate by at least 6 inches, except at unavoidable crossover points and at device terminations.
    b. All wiring shall be bundled and supported by straps.
11. Separation of intrinsically safe circuit conductors and non-intrinsically safe circuit conductors:
    a. Secure conductors so that any intrinsically safe circuit conductor that might come loose from a terminal is unlikely to come into contact with another terminal.
    b. Separate non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by one of the following methods:
        1) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by at least 2 inches (50 mm).
        2) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of a grounded metal partition 0.0359 inches (0.91 mm) or thicker.
        3) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of an approved insulating partition that extends to within 0.0625 inches (1.5 mm) of the enclosure walls.
        4) Where either (1) all of the intrinsically safe circuit conductors or (2) all of the non-intrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.
    c. Blue wire-duct shall be used for wires carrying intrinsically safe circuit conductors.
12. Separate different intrinsically safe circuit conductors from each other by one of the following means:
    a. The conductors of each circuit are within a grounded metal shield.
    b. The conductors of each circuit have insulation with a minimum thickness of 0.01 inches (0.25 mm).
13. Provide minimum clearance of 0.125 inches (3 mm) between uninsulated parts of intrinsically safe field wiring conductors connected to terminals and grounded metal or other conducting parts.
14. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.

15. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 degrees C.
    a. Conductor size shall be as required for load and 16 AWG minimum.
    b. Internal panel wiring color code:
        1) AC circuits:
            a) Power wiring: Black.
            b) Control interconnections: Red.
            c) Neutral: White.
            d) Ground: Green.
        2) Low voltage DC circuits:
            a) Power wiring: Dark Blue(+) and White with Blue stripe.
            b) Control interconnections: Dark Blue.
        3) Foreign voltage circuits: Yellow.
        4) Annunciator circuits: Red.
        5) Intrinsically safe circuits: Light Blue.
16. Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs.
    a. Conductor size: 18 AWG minimum.
    b. Terminate shield drain conductors to ground only at one end of the cable.
17. High precision 250 ohm resistors with 0.25 % accuracy shall be used where 4 - 20 mA DC analog signals are converted to 1 - 5 VDC signals.
    a. Resistors located at terminal strips.
    b. Resistors terminated using individual terminal blocks and with no other conductors.
    c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.
18. Analog signals for devices in separate enclosures shall not be wired in series.
    a. Loop isolators shall be used where analog signals are transmitted between control enclosures.
19. Wire and cable identification:
    a. Wire and cables numbered and tagged at each termination.
    b. Wire tags:
        1) See Section 10 14 00 - Identification Devices.

E. Grounding Requirements:
1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
3. Bond electrical racks, chassis and machine elements to a central ground bus.
    a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
4. Bond the enclosure to the ground bus. Bonded connections shall be free of paint and debris.
5. It is imperative that good electrical connections are made at the point between the ground bus and enclosure.
6. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
7. Sub-panels and doors shall be bonded to ground.
8. Associated apparatus (connected to intrinsically safe circuits) and associated cable shields:

a. Ground in accordance with the associated control drawing (drawing provided for the intrinsically safe circuit and which contains manufacturer's entity parameters).

F. Termination Requirements:

1. Wiring to circuits external to the panel connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on DIN rail mounting channels.
3. Electrical connections to terminal blocks shall be terminated with a proper torque tool as per manufacturer terminal block instructions. Terminating conductors without a torque tool can result in improper and unsafe installation.
4. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
5. One side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
6. Terminal block markings:
   a. Marking shall be the same as associated wire marking.
   b. Legible, machine-printed markings.
   c. Markings as identified in the shop drawings.
   d. Terminal block markings shall follow a consecutive numbering sequence. Terminal block numbers with a random numbering sequence are not acceptable.
7. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
8. Terminal blocks with continuous marking strips.
   a. Each terminal block shall be identified with machine printed labels.
9. Terminals shall facilitate wire sizes as follows:
   a. 120 VAC applications: Conductor size 12 AWG minimum.
   b. Other: Conductor size 14 AWG minimum.
10. Analog signal cable shield drain conductors shall be individually terminated.
11. Install minimum of 20 % spare terminals.
12. Fused terminal blocks shall be used in the following circuits:
    a. Control voltage is used to energize a solenoid valve.
    b. DC power is connected to 2-wire, loop-powered instruments.
13. Fused terminal blocks shall be provided with blown fuse indicators.
14. When control circuits require more than one field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one field conductor per terminal block.
15. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.
16. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.
17. Intrinsically safe circuit termination:
    a. Provide at least 0.25 inches (6 mm) clearance between two terminals for connection of field wiring of different intrinsically safe circuits, unless this clearance is permitted to be reduced by the control drawing this is provided for the intrinsically safe circuit and which contains manufacturer's entity parameters.
    b. Identify intrinsically safe circuits at terminal and junction locations in a manner that is intended to prevent unintentional interference with the circuits during testing and servicing as required by NEC, Article 504.
    c. Terminal blocks used for intrinsically safe wires shall be blue.

G. Component Mounting and Placement:

1. Components shall be installed per manufacturer instructions.

2. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
3. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.
4. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.
5. Front panel devices shall be mounted within a range of 40 to 70 inches above the finished floor, unless otherwise shown in the Contract Documents.
6. PLC/RTU and I/O rack installation:
    a. Located such that the LED indicators and switches are readily visible with the panel door open.
    b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.
7. Locate power supplies with sufficient spacing for circulation of air.
8. Where components such as magnetic starters, contactors, relays, and other electromagnetic devices are installed within the same enclosure as the PLC/RTU system components, provide a barrier of at least 6 inches of separation between the “power area containing the electromagnetic devices” and the “control area”.
9. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
    a. Fastening devices shall not project through the outer surface of the panel enclosure.
10. Excess mounting space of at least 20 % for component types listed below to facilitate future expansion:
    a. Fuse holders.
    b. Circuit breakers.
    c. Control relays.
    d. Time delay relays.
    e. Intrinsically safe barriers and relays.
11. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 inch.
    a. Minimum of 2 inches separation between terminal strips and wire ducts.
12. Pneumatic tubes and appurtenances:
    a. Connect panel air piping and tubing penetrations with bulkhead fittings.
    b. Pneumatic control tubing shall be 1/4 inches OD.
        1) Tubing material: Either soft annealed ASTM B75 copper or flame-resistant polyethylene.
    c. Main headers within panels shall be minimum 1 inch.
    d. Compression-type pressure fittings.
    e. Equip panel instrument leads with ball type isolation valve.
    f. Route tubing neatly and mount securely.
    g. Do not route tubing in front of or in wire ducting.
    h. Code terminal plates.
    i. Pneumatic devices shall be served by a dual function filter regulator.

H. Power Distribution:

1. Control panels powered by voltage greater than 120 VAC (nominal) main incoming power shall be provided with a disconnect switch mounted within the enclosure.
    a. Disconnect switch shall be interlocked with the enclosure door(s).
    b. Disconnect switches that supply motor loads shall comply with NEC Code part IX of article 430.

2. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
    a. Limit load to maximum of 80 % of circuit breaker rating.
3. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
    a. PLC/RTU power supply modules.
    b. Single-loop controllers.
    c. Operator interface terminals/HMI.
    d. DC power supplies.
    e. Alarm annunciators.
4. Each control panel with PLC/RTU components shall be furnished with power protection in the form of a double conversion UPS.
5. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 % spare capacity.
6. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.
7. Circuit breakers and fuses shall be used to protect equipment powered inside and outside enclosure
    a. Circuit breakers shall be UL489.
    b. UL489 circuit breaker shall be finger safe.
    c. Fuses shall be 1/4 x 1-1/4 inches size.

I. Internal Panel Lighting and Service Receptacles:
1. Panels less than or equal to 4 feet wide:
    a. One electrical GFCI duplex receptacle.
    b. One LED light fixture with manual switch(es).
2. Panels or panel faces greater than 4 feet wide:
    a. One duplex electrical GFCI receptacle per 6 feet of length.
    b. Continuous LED lighting strip with manual switches.

J. Security Controls:
1. Provide all control panels and enclosures with door switch monitored by discrete input utilizing normally closed contacts.
2. Configure door switch as an [alarm] [event] at the HMI.

K. Environmental Controls:
1. Indoor panels located in a designated electrical room or control room:
    a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
    b. Internal corrosion inhibitors.
2. Indoor panels not located within a designated electrical room or control room:
    a. Thermostat controlled heaters to maintain temperature approximately 10 degrees F above ambient for condensation prevention inside the panels.
    b. Automatically controlled, closed-loop heat exchangers or closed-loop air conditioners where required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel(s).
    c. Internal corrosion inhibitors.
3. Outdoor panels:
    a. Outdoor temperature range of 0 degrees F through 120 degrees F.

b. Thermostat controlled heaters to maintain temperature approximately 10 degrees F above ambient dew point for condensation prevention inside the panels.
c. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel.
d. Internal corrosion inhibitors.

4. Environmental control components:
   a. Panel heaters:
      1) Thermostat controlled.
      2) Fan driven.
      3) Components mounted in an anodized aluminum housing.
      4) Designed for sub-panel mounting.
      5) Powered from 120 VAC and protected with a dedicated circuit breaker.
   b. Cooling fans and exhaust packages:
      1) Cooling fan with louver or grill and replaceable filter.
      2) Designed to be mounted within a panel cutout to provide positive airflow through the panel.
      3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.
      4) Fitted with replaceable, high-density foam or synthetic fiber.
      5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
      6) Powered from 120 VAC and protected with a dedicated circuit breaker.
   c. Heat exchangers and air conditioners:
      1) Dual-loop design to isolate panel interior air from exterior air.
      2) Thermostat controlled.
      3) Operate from 120 VAC and protected with a dedicated circuit breaker.
   d. Internal corrosion inhibitors:
      1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
      2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.
      3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

2.4 UNWITNESSED FACTORY TESTING

A. Inspect and test entire panel assembly to verify readiness for shipment or readiness for the Engineer and/or Owner to attend factory testing if specified in Section 40 61 21 - Process Control System Testing.

B. Location: Panel fabricator's factory.

C. Tests shall be fully documented and signed by the panel fabricator's factory supervisor.

D. The panel shop shall fully test the control panel for correct wiring.

   1. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.

E. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 hours.

F. A PLC Central Processing Unit (CPU) shall be obtained and connected to the panel(s) if necessary for testing purposes.

G. Testing equipment (such as digital multi-meters, analog loop calibrators, and laptop computers with PLC programming software) shall be used as required for testing.

H. The following functions shall be tested as a minimum:

1. Verify functions of the panel(s) required by the Contract Documents.
2. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
3. Simulate and test each discrete signal at the field terminal strips.
4. Simulate and test each analog signal using loop calibrators.
5. Correct operation of communications between PLC system Central Processing Units (CPUs) and Remote I/O bases.
6. Correct operation of single-loop controllers (including digital communication to microprocessor based devices).
7. Correct operation of all digital communication devices.
8. Verify online and offline diagnostic tests and procedures.

I. Deficiencies shall be corrected prior to requesting the Engineer and/or Owner to attend factory testing if specified, or prior to shipment from the Contractor's factory.

2.5 SOURCE QUALITY CONTROL

A. Perform Factory Acceptance Testing as specified in Section 40 61 21 - Process Control System Testing.

2.6 MAINTENANCE MATERIALS

A. Extra Materials:

1. Quantity of 25 % replacement lamps for each type installed (minimum of 12 of each type).
2. Minimum 12 replacement filters for each type installed.
3. 1 QT of exterior finish touch-up paint.
4. One complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install freestanding panels on 4 inches high concrete housekeeping pads.

B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.

C. Obtain approved panel layouts prior to installation of conduits.

D. Install products in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 40 71 00
FLOW INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Flow Transmitters:
   a. Magnetic Flow Meters (Inline).
   b. Open Channel Flow Meters -Parshall Flumes.
2. Flow Switches:
   a. Thermal Dispersion Type Flow Switches
   b. Disk/Vane-Operated Flow Switches.
   c. Presence/Absence Detectors (Dry Run Protection)

B. The instruments specified in this Specification Section are the primary element components for the control loops which are specified in Specification Section 40 61 96 and shown on the Control System Drawings.

1. These instruments are integrated with other control system components specified under Specification Section 40 61 13 to produce the functional control system defined in the Contract Documents

C. Related Specification Sections include but are not necessarily limited to:

1. Section 40 61 13 - Process Control System General Requirements.
2. Section 40 61 96 - Process Control Descriptions.
3. Section 40 70 06 - Schedule of Instrumentation for Process Systems

D. Referenced Standards:

1. American Gas Association (AGA):
   a. Gas Measurement Committee Report #3.
2. American Society of Mechanical Engineers (ASME):
   a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   b. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   c. B16.5, Pipe Flanges and Flanged Fittings.
   d. B626, Standard Specification for Welded Nickel and Nickel-Cobalt Alloy Tube.
   e. PTC 19.5, Application of Fluid Meters, Part 2.
3. ASTM International (ASTM):
   a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
4. American Water Works Association (AWWA).
5. National Sanitation Foundation (NSF).
6. US Department of Interior Bureau of Reclamation (USDIBR):
   a. Water Measurement Manual.
7. Idaho Department of Water Resources - Approved Full Profile Magnetic Flow Meters

1.2 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 78 23 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 FLOW TRANSMITTERS

A. Magnetic Flow Meters (Inline):

1. Acceptable manufacturers:
   a. Krohne (Waterflux 3100 C/F).
   b. McCrometer Ultra Mag with M-series converter
   c. Rosemount (8700 Series).
   d. Siemens (SITRANS F M).
2. Accessories:
3. Design and fabrication:
   a. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
   b. Flow meter accuracy shall be +/- 0.5% of measured value with 3 pipe diameters of upstream (US) straight pipe run and 1 pipe diameter of downstream straight pipe run.
   c. Provide flanged end connections per ASME B16.5 up to 24 inches rated for piping system operating and test conditions. Meter body shall be rated to same pressure as the flanges.
   d. Grounding requirements:
      1) Nonmetallic or lined pipe:
         a) Inlet and outlet grounding rings of same material as electrode or as recommended by manufacturer to meet process requirements.
      2) Conductive piping:
         a) Conductive path between the meter and the piping flanges.
   e. Provide cable between magnetic flow meter and transmitter.
      1) Cable shall be potted and fitted by manufacturer at the factory.
   f. Pulsed DC magnetic field excitation.
   g. Automatic zero.
   h. Adjustable low flow cutoff.
   i. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
   j. 4-20 mA DC [HART] isolated output into maximum 800 ohms.
   k. Power supply: 117 V ±10%, 60 Hz.
   l. Indication of flow rate and totalized flow at transmitter.
   m. Meter operable as specified in liquids with 5.0 micro mho/cm or more conductivity.

n. Transmitter electronics shall use microprocessor based architecture and be configured using parameters.

o. All meters for drinking water service shall be NSF 61 certified.

4. Schedule:

TAG NUMBER	SERVICE	FLOW RANGE (GPM)	METER SIZE (IN)	NEMA (IP) RATING

TAG NUMBER	LINER MATERIAL	ELECTRODE MATERIAL	INTEGRAL, FIELD OR PANEL-MOUNTED TRANSMITTER

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

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SECTION 40 72 00
LEVEL INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Level Transmitters:
   a. Capacitance Level Sensor and Transmitter.
   b. Guided Wave Radar Level Sensor and Transmitter.
   c. Submersible Level Sensor and Transmitter.
   d. Float Type Level Sensor and Transmitter.
2. Level Switches:
   a. Float-Tilt Type Level Switch.
   b. Displacement Type Level Switch.
   c. Tuning Fork Type Level Switch.
3. Level Indicators:
   a. Glass Gauge.
   b. Flag Gauge.

A. The instruments specified in this Specification Section are the primary element components for the control loops which are specified in Specification Section 40 61 96 and shown on the Control System Drawings.

1. These instruments are integrated with other control system components specified under Specification Section 40 61 13 to produce the functional control system defined in the Contract Documents

B. Related Specification Sections include but are not necessarily limited to:

1. Section 40 61 13 - Process Control System General Requirements.
2. Section 40 61 96 – Process Control Descriptions.
3. Section 40 70 06 - Schedule of Instrumentation for Process Systems

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings.
2. ASTM International (ASTM):
   a. A106, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
   b. A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 78 23 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 LEVEL TRANSMITTERS

A. Capacitance Level Sensor and Transmitter:
   1. Manufacturers:
      a. Endress + Hauser (*Liquicap* FM 151/152).
      b. Magnetrol (*Kotron* series).
      c. Siemens (*Sitrans* LC300).
   2. Specifications:
      a. General.
         1) Measurement Principle: Change in capacitance of the liquid covering the probe
            a) Liquid or Solids.
            b) Ability to protect against vapors, agitation, and bubbling.
            c) Connection on top of tank.
         2) Measurement Range (see Schedule):
            a) 1.66 to 3300 pF.
         3) Accuracy: 0.5% of measured value.
         4) Temperature Stability: 0.25% of actual capacitance.
      b. Process Connection:
         1) Threaded (NPT): See Schedule.
         2) Flange (ASME): see Schedule.
      c. Display and Configuration:
         1) Integral Display for live measurement and configuration.
         2) Adjustable zero and span.
         3) Output variable: Level.
         4) Output Units: Feet, inches, meters, or millimeters (mm).
      d. Electrical:
         1) Signal Power: Loop-powered, 2-wire, 24 VDC.
         2) Current Output: Analog 4-20 Ma into a 400 ohm loop.
         3) Optional Communication: HART.
         4) Configuration: With remote hand-held configurator.
         5) Cable entry: 3/4 inches NPT connection.
      e. Mechanical:
         1) Sensor:
            a) Material: 316L/PFA or 316 SS.
            b) Diameter: 0.75 inches.
         2) Enclosure: Aluminum, epoxy-coated.
      f. Environment:
         1) Ambient Temperature: -40 to 158 degrees F (-40 to 70 degrees C).
         2) Humidity: Up to 99%.
         3) Process Temperature: -4 to 185 degrees F (-20 to 85 degrees C).

4) Process Pressure: 0 to 150 psiG.
5) Protection: Refer to Area Classification Drawings.

3. Schedule (or Instrument List):

TAG NUMBER	SERVICE	RANGE	PROCESS CONNECTION	REFERENCE DRAWING

B. Guided Wave Type Radar Level Transmitter:

1. Manufacturers:
   a. Emerson Rosemount (3300 Series).
   b. Endress + Hauser (*LevelFlex* FMP5x).
   c. Siemens (*Sitrans* LG or LR).
2. Specifications:
   a. General.
      1) Measurement Principle: Microwave pulses guided down a probe submerged in the process media; changes in the process dielectric constant are used.
         a) Level and Interface Measurement.
         b) Ability to protect against vapors and turbulence.
         c) Connection on top of tank.
         d) Cut to fit probes.
         e) Applications: Liquids.
         f) No compensation needed for process changes such as pressure, temperature, density, or conductivity.
      2) Measurement Range (see Schedule):
         a) Cable/twin rod version: up to 77 feet.
         b) Coax version: Up to 20 feet.
      3) Accuracy: 0.1% of measurement.
      4) Repeatability: ±0.04 inches.
      5) Temperature Stability: 0.01% of measurement.
   b. Design and fabrication:
      1) Linearity:
         a) Coaxial/twin rod: ±0.2 inches or 0.2% of probe length (whichever is greater).
         b) Single rod: ±0.3 inches or 0.3% of probe length (whichever is greater).
      2) Measured error:
         a) Coaxial/twin rod: ±0.2 inches or 0.2% of probe length (whichever is greater).
         b) Single rod: ±0.5 inches or 0.5% of probe length (whichever is greater).
      3) Resolution: 0.1 inches.
      4) Repeatability: ±0.1 inches.
      5) Response time: 1 second.
   c. Process Connection:
      1) Threaded (NPT): See Schedule.
      2) Flange (ASME): see Schedule
   d. Display and Configuration:

1) Integral Display for live measurement and configuration.
2) Adjustable zero and span.
3) Output variable: Level.
4) Output Units: Feet, inches, meters, or millimeters (mm).

e. Electrical:
1) Signal Power: Loop-powered, 2-wire, 24 VDC.
2) Current Output: Analog 4-20 Ma into a 400 ohm loop.
3) Optional Communication: HART.
4) Configuration: With remote hand-held configurator.
5) Cable entry: 3/4 inches NPT connection.
6) Complies with FCC Part 15.

f. Mechanical:
1) Probe:
a) Material: 316L/SST.
b) Diameter: 0.75 inches.
2) Enclosure: Aluminum, epoxy-coated.

g. O-rings: Viton.

h. Flanges: Plastic.

i. Environment:
1) Ambient Temperature: -40 to 185 degrees F (-40 to 85 degrees C).
2) Humidity: Up to 99%.
3) Process Temperature: -4 to 185 degrees F (-20 to 85 degrees C).
4) Process Pressure: 0 to 150 psiG.
5) Protection: Refer to Area Classification Drawings.
6) Schedule (or Instrument List):

TAG NUMBER	SERVICE	PROBE TYPE and MATERIAL	PROBE LENGTH	MOUNT TYPE and SIZE

C. Submersible Level Sensor and Transmitter:
1. Manufacturers:
a. Endress + Hauser (*Waterpilot* FMX21).
b. Druck (Series 1830/1840).
c. In-Situ (PXD-261/461).
2. Specifications:
a. General:
1) Measurement Principle: Differential-pressure (hydrostatic) based on the height of the liquid head with the use an integrated strain gauge or Ceramic Capacitive Sensor (CCS).
a) Open (to atmosphere) or Closed Tanks.
b) Fully submersible.
c) Vented cable.
2) Minimum/Maximum Span: 1 to 100 psiG (2.31 to 230.67 feet).
3) Accuracy: ±0.25% of span.

b. Process Connection:
   1) None: Mount vertically at the bottom of tank.
   2) Option: 1/4 inches NPT connection on tank.
c. Display and Configuration:
   1) Output variables: Pressure (converted to level).
   2) Output Units: psi.
d. Electrical:
   1) Signal Power: Loop-powered, 2-wire, 24 VDC.
   2) Current Output: Analog 4-20 Ma into a 600 ohm loop.
   3) Cable entry: 1/4 inches NPT connection to attached jacketed cable.
e. Materials of Construction:
   1) Probe: 316SS, Viton, Titanium.
   2) Cable: Hytrel, FEP, HDPE
f. Environment:
   1) Ambient Temperature: -40 to 212 degrees F (-40 to 1000 degrees C).
   2) Humidity: Up to 100%, non-condensing.
   3) Process Temperature: -4 to 104 degrees F (-20 to 60 degrees C).
   4) Process Pressure: 0 to 35 psiG.

3. Schedule (or Instrument List):

TAG NUMBER	SERVICE	RANGE	AREA CLASSIFICATION

D. Float Type Level Transmitter:
1. Manufacturers:
   a. FlowLine (LV).
   b. GEMS (XM/XT).
   c. Omega (LVR).
2. Specifications:
   a. General:
      1) Measurement Principle: Single water float operated type transmitters
      2) Self-contained and provides a continuous level signal.
   b. Float Sensor:
      1) Direct acting type requiring no float pipe, stilling well, or other such device.
      2) Immune to density and dielectric changes.
      3) Resolution: 1/4 inches.
      4) Process Temperature: Up to 180 degrees F.
      5) Maximum Pressure: 300 psiG.
      6) Minimum Specific Gravity: 0.75.
   c. Level Transmitter:
      1) Threaded cover.

2) Enclosure: NEMA 4X (IP65).
3) 2-wire: 24 VDC loop-powered 4-20 mA signal into a maximum 600 ohm loop.
4) Conduit entrance: 1/2 inches NPT.
5) Process Connection: 2 inches NPT.

d. Materials:
1) Float and Float Stop: 316SS, _____.
2) Stem and Mounting: 316SS, _____.
3) Transmitter Case: PP, Cast aluminum.

3. Schedule (or Instrument List):

TAG NUMBER	SERVICE	RANGE

2.3 LEVEL SWITCHES

A. Float-Tilt Type Level Switch:

1. Manufacturers:
a. Anchor Scientific Inc.
b. Consolidated Electric.
c. Contegra.

2. Materials:
a. Float material: Polypropylene or Teflon coated type 316 stainless steel.
b. Cable jacket: PVC, neoprene.
c. Cable clamp: Polypropylene or 316 stainless steel.

3. Design and fabrication:
a. Mercury-free switch.
b. Provide switch complete with flexible electrical cables.
c. SPDT contact rated at 1 amp at 120 VAC.
d. Direct acting float switch:
1) Switch actuates on rising level.
2) Switch deactuates when liquid falls 1 inch below actuation level.
e. Terminate cables in junction box.
f. Process temperature: max. 120 degrees F.
g. Install floats per drawing details.

4. Schedule (or Instrument List):

TAG NUMBER	SERVICE	CONTACT NO / NC / NO-NC	MOUNTING ELEVATION	MOUNTING (Suspended or Pipe)

B. Displacement Type Level Switches:

1. Acceptable manufacturer:
   a. Magnetrol.
2. Materials:
   a. Displacer: Porcelain.
   b. Support rod or cable: 316 stainless steel.
   c. Mounting bushing or flange: Carbon steel.
3. Design and fabrication:
   a. Displacer supported by rod or cable suspended on spring.
   b. Switch type: Dry contact.
   c. Mercury-free switch.
   d. Cable: 10 feet maximum.
   e. Mounting: Flanged or Threaded.
   f. Setpoints: Field adjustable.
   g. Switch contacts:
      1) SPDT.
      2) Rated 5 amps inductive at 120 VAC.
   h. Process temperature: Maximum 250 degrees F.
4. Schedule (or Instrument List):

TAG NUMBER	SERVICE	DISPLACER ELEVATIONS	TANK CONNECTION

C. Tuning Fork Type Level Switch:
   1. Manufacturers:
      a. Emerson Rosemount (2120).
      b. Endress + Hauser (*Liquiphant M* FTL 50/512).
      c. Siemens (*Sitrans* LVL 100/200).
   2. Specifications:
      a. General: Vibrating Fork technology; change in tuning fork frequency when the liquid covers the probe.
         1) The denser the liquid the lower the frequency.
         2) Unaffected flow, bubbles, turbulence, or foam.
         3) Probe should be designed so that the liquid flows away quickly.
         4) No moving parts.
         5) Can be mounted vertically or horizontally.
         6) Hysteresis: 0.08 inches.
      b. Process Connection:
         1) Threaded (NPT): See Schedule.
         2) Flange (ASME): See Schedule.
      c. Display and Configuration:
         1) LED Status.
      d. Electrical:

1) Power: 24 VDC.
2) Relays: DPDT contacts, Transistor PNP.
3) Mercury-free switch.
4) Cable Entry: 3/4 inches.

3. Materials:
   a. Probe: 316L SS.
   b. Enclosure: Aluminum, epoxy-coated, 316L
   c. Rating: Refer to Area Classification Drawings.
4. Environment:
   a. Ambient Temperature: -40 to 158 degrees F (-40 to 70 degrees C).
   b. Humidity: 99%, non-condensing.
   c. Process Temperature: -40 to 302 degrees F (-40 to 150 degrees C).
   d. Process Pressure: 0 - 100 psiG.
5. Schedule (or Instrument List):

TAG NUMBER	SERVICE	SETPOINTS	PROCESS CONNECTION

2.4 LEVEL INDICATORS

A. Glass Gauge.

1. Manufacturers:
   a. Ernst Flow Industries.
   b. JW Winco, Inc.
2. Specifications:
   a. Gage glasses shall be of the type and design for the operating pressure and temperature.
   b. Gage glasses shall be complete with shutoff cocks and drain cocks.
      1) Shutoff cocks shall be furnished with built-in check valves.
      2) Guard bars shall be furnished to protect against glass breakage.
3. Schedule (or Instrument List):

TAG NUMBER	SERVICE	RANGE	PROCESS CONNECTION

B. Magnetic (Flag) Level Gauge.

1. Manufacturers:
   a. Emerson Magtech.
   b. Magnetrol Orion.
   c. Pentair / Penberthy.

2. Specifications:
   a. General:
      1) Measurement Principle: Magnetic equipped float inside a chamber that actuates “flag” level indicators.
      2) Visual indication up to 100 feet.
      3) Manufactured to ASME B31.1 or B31.3.
   b. Physical:
      1) Chamber: 2-1/2 inches welded pipe.
      2) Chamber material: 300 series stainless wetted parts.
      3) Chamber flanges: ANSI B16.5 RF slip-on type.
      4) Process Connections: One-inch diameter, 3,000 psig.
      5) Float Assembly: 300 series stainless steel suitable for up to 1000 psiG and 1000 degrees F.
      6) Indicators: red and silver, high temperature design with 1/3 inches resolution.
      7) Indicator Units: Decimal feet.
   c. Options:
      1) Level Transmitter:
         a) Type: Guided-wave Radar.
      2) Level Switches:
         a) Type: [Magnetically-actuated] [Cam-actuated].
      3) Insulation.
      4) Heat-tracing.
3. Schedule (or Instrument List):

TAG NUMBER	SERVICE	RANGE	PROCESS CONNECTION

2.5 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
   1. Materials, unless otherwise specified, shall be as follows:
      a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
      b. Mounting brackets:
         1) Standard: 316 stainless steel.
         2) Highly corrosive areas: Aluminum.
      c. Mounting plates, angles:
         1) Standard: Carbon steel.
         2) Corrosive areas: 316 stainless steel.
      d. Instrument pipe stands:
         1) Standard: Hot-dip galvanized 2 inches schedule 40, ASTM A106, Grade B carbon steel.
         2) Corrosive areas: 316 stainless steel.

B. Provide handheld communicator compatible for all intelligent transmitters furnished.

1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
2. If these features are provided with the intelligent transmitter that is accessible, the hand held communicator is not required.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Valves:

1. Orient stems for proper operation.
2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
3. Provide a minimum of 2 inches clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
   a. When cool, reassemble the valves.
5. Support each valve individually.
   a. The tubing system does not qualify as support for the valve.

D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Remove all oil on piping and tubing with solvent before piping and tubing installation.

G. Plug all open ends and connections to keep out contaminants.

H. Threaded Connection Seals:

1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

I. Instrument Mounting:

1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
   a. Protect from heat, shock, and vibrations.
   b. Provide accessibility for maintenance.
   c. Free from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

SECTION 40 73 00
PRESSURE INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure Transmitters.
   a. Pressure Transmitters (Gauge and Absolute).
   b. Differential Pressure Transmitters.
2. Pressure Switches.
   a. Electro-Mechanical.
   b. Solid-state / Electronic.
3. Pressure Indicators.
   a. Pressure Gauges – Mechanical.
   b. Pressure Gauges - Digital.
4. Isolation Devices.
   a. Diaphragm Seals.
   b. In-Line Isolation Sleeve (Annular Seal).

B. Related Specification Sections include but are not necessarily limited to:

1. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Society of Mechanical Engineers (ASME):
   a. B16.5, Pipe Flanges and Flanged Fittings
2. ASTM International (ASTM):
   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 61 13.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 78 23 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 PRESSURE TRANSMITTERS

A. Pressure Transmitters (Gauge and Absolute):

1. Manufacturers:

a. Emerson Rosemount (3051).
b. Endress + Hauser (Cerabar S).
c. Honeywell (ST 3000 Series 100).
d. Schneider Electric / Foxboro (IGP/IAP).
e. Siemens (SISTRANS P500).

2. Materials:
   a. Process flanges and adapters: 316 stainless steel.
   b. Vent/drain valve: 316 stainless steel.
   c. Isolating diaphragm: 316 stainless steel.
   d. Housing: Aluminum.
   e. Fill fluid:
      1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
         a) Agents include but are not limited to: Cl2, KMN04, FeCl, Na0H, and Na0Cl.
      2) Utilize manufacturer's standard fill for other applications.
         a) Ensure fill is suitable for application temperatures.
3. Design and fabrication:
   a. Smart transmitters utilizing microprocessor based electronics.
   b. Signal Output: 4-20 mA DC proportional to pressure.
   c. Optional Communication: HART.
   d. Nonvolatile EEPROM memory.
   e. Power supply: 24 VDC Loop Power.
   f. Adjustable zero and span.
   g. Temperature limits:
      1) -20 to 180 degrees F (without digital display).
      2) -4 to 175 degrees F (with digital display).
   h. Overpressure limits: Withstand 150% of stated maximum service pressure without damage.
   i. Humidity limits: 0 to 100% relative humidity.
   j. Damping: Adjustable between 0 and 60 seconds.
   k. Accuracy (includes effects of linearity, repeatability and hysteresis): ±0.10% of calibrated span for 15:1 rangeability.
   l. Stability: ±0.2% of upper range limit for 12 months.
   m. Temperature effect:
      1) Total effect including span and zero errors: + 0.2% of upper range limit per 100 DEGF for minimum 15:1 rangeability.
   n. Minimum 1/2 inches pressure connection.
   o. Equip with test jacks or accessible terminals for testing output.
   p. Equip with isolation valve and test connections with isolation valves and/or plugs.
4. Schedule: (or Instrument List).

TAG NUMBER	SERVICE	RANGE	PROCESS CONNECTION	VALVE MANIFOLD

B. Differential Pressure Transmitters:

1. Manufacturers:
   a. Emerson Rosemount (3051).
   b. Endress + Hauser (Deltabar S).
   c. Honeywell (ST 3000 Series 100).
   d. Schneider Electric / Foxboro (IGP/IAP).
   e. Siemens (SISTRANS P500).
2. Materials:
   a. Process flanges and adapters: 316 stainless steel.
   b. Vent/drain valve: 316 stainless steel.
   c. Isolating diaphragm: 316 stainless steel.
   d. Housing: Aluminum.
   e. Fill fluid:
      1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
         a) Agents include but are not limited to: Cl2, KMN04, FeCl, Na0H, and Na0Cl.
      2) Utilize manufacturer's standard fill for other applications.
         a) Ensure fill is suitable for application temperatures.
3. Design and fabrication:
   a. Smart transmitter utilizing microprocessor based electronics.
   b. Signal Output: 4-20 mA DC proportional to differential pressure.
   c. Optional Communication: HART.
   d. Nonvolatile EEPROM memory.
   e. Power supply: 24 VDC Loop Power.
   f. Adjustable zero and span.
   g. Temperature limits:
      1) -20 to 180 degrees F (without digital display).
      2) -4 to 175 degrees F (with digital display).
   h. Overpressure limits:
      1) Withstand body rated pressure on either side without damage or loss of calibration.
      2) Withstand 150% of stated maximum service pressure without damage.
   i. Humidity limits: 0 to 100% relative humidity.
   j. Damping: Adjustable between 0 and 60 seconds.
   k. Accuracy (includes effects of linearity, repeatability and hysteresis): ±0.10% of calibrated span for 15:1 rangeability.
   l. Stability: ±0.2% of upper range limit for 12 months.
   m. Temperature effect:
      1) Total effect including span and zero errors: ±0.2% of upper range limit per 100 degrees F for minimum 15:1 rangeability.
   n. Minimum 1/2 inches pressure connection.
   o. Equip with test jacks or accessible terminals for testing output.
   p. Equip with a three-valve manifold as follows:
      1) Two transmitter isolating valves.
      2) One transmitter equalizing valve.
   q. Provide with test connections with isolation valves and/or plugs.
4. Schedule: (or Instrument List).

TAG NUMBER	SERVICE	RANGE	PROCESS CONNECTION	VALVE MANIFOLD

2.3 PRESSURE SWITCHES

A. Electro-Mechanical:

1. Manufacturers:
   a. Allen-Bradley (Model 836).
   b. Emerson / ASCO (S Series).
   c. Mercoid (Series DA/DS or SA1100).
2. Materials:
   a. Wetted switch elements: 316 stainless steel.
   b. Diaphragm seal housing: 316 stainless steel.
   c. Pressure snubber:
      1) Filter disc: 316 stainless steel.
      2) Housing: 316 stainless steel.
3. Accessories:
   a. Provide ball valve to isolate pressure switch from source.
   b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on pressure switch as shown on schedule.
   c. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
4. Design and fabrication:
   a. Utilize “Snap Action” type contact switches.
   b. No external power needed.
   c. One SPDT contact rated:
      1) 0.5 amps inductive at 125 VDC.
      2) 5 amps inductive at 120 VAC.
   d. Switch set points:
      1) Above 1,000 psi:
         a) Between 30 and 35% of switch rated working range.
         b) Operating pressure range not to exceed 35% of switch rated working pressure.
      2) Below 1,000 psi:
         a) Set points between 30 and 70% of switch rated working range.
         b) Operating pressure not to exceed 75% of switch rated working range.
   e. Accuracy: ±1% of full scale.
   f. Process connection: Minimum of 1/4 inches.
   g. Conduit connection: Minimum of 1/2 inches.
5. Schedule:

TAG NUMBER	SERVICE	LOW SETTING	HIGH SETTING	ENCLOSURE RATING	SNUBBER REQ'D

B. Solid State / Electronic.

1. Manufacturers:
   a. Allen-Bradley (836P).
   b. Ashcroft (N Series).
   c. Endress + Hauser (Ceraphant T).
   d. GEMS (3600 Series or PS98).
2. Materials:
   a. Wetted switch elements: 316 stainless steel.
   b. Diaphragm seal housing: 316 stainless steel.
   c. Pressure snubber:
      1) Filter disc: 316 stainless steel.
      2) Housing: 316 stainless steel.
3. Accessories:
   a. Provide ball valve to isolate pressure switch from source.
   b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on pressure switch as shown on schedule.
   c. On applications where a pressure switch and a pressure gauge are used at the same location, it is permissible to utilize one pulsation dampener and diaphragm seal to isolate both elements from the process fluid.
4. Design and fabrication:
   a. No moving parts; fully hermetically sealed.
   b. 12 VDC or 24 VDC powered.
   c. Relay or Transistor outputs.
   d. Switch set points: Adjustable setpoints and deadbands.
   e. Accuracy: ±0.5% of full scale.
   f. Process connection: Minimum of 1/4 inches.
5. Schedule:

TAG NUMBER	SERVICE	LOW SETTING	HIGH SETTING	ENCLOSURE RATING

2.4 PRESSURE INDICATORS

A. Pressure Gauge - Mechanical:

1. Manufacturers:
   a. Ametek / USGauge (Solfrunt Model 1980).
   b. Ashcroft (Type 1279 or 1379).
2. Materials:

a. Bourdon tube, socket, connecting tube: 316 stainless steel.
b. Case: Phenolic.
c. Pressure snubber:
1) Filter disc: 316 stainless steel.
2) Housing: 316 stainless steel.

3. Accessories:
a. Provide valve at point of connection to equipment and at panel if panel mounted.
b. Utilize pressure snubber with porous metal discs to provide pulsation dampening on gauge applications as shown on schedule.
c. Provide 1/2 inches stainless steel anti-siphon pigtail inlet connection for hot water and steam applications.

4. Design and fabrication:
a. All components suitable for service at:
1) 250 degrees F.
2) The maximum process temperature to which the gauge is to be exposed.
b. Provide viewer protection from element rupture.
c. Calibrate gauges at jobsite for pressure and temperature in accordance with manufacturer's instructions.
d. Unless otherwise required by codes, provide stem mounted or flush mounted, as required, with dial diameter as follows:

PIPE SIZE	DIAL SIZE	GAUGE CONNECTION
1-1/2 inches or less	2-1/2 inches	1/4 inches
Larger than 1-1/2 inches	4-1/2 inches	1/2 inches

e. Equip with white faces, black numerals and black pointers.
f. Gauge tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
1) Gauge to be readable from an accessible standing position.
g. Gauge accuracy: 1% of full range.
h. Select gauge range so that:
1) The normal operating value is in the middle third of the dial.
2) Maximum operating pressure does not exceed 75% of the full scale range.

5. Schedule:

TAG NUMBER	SERVICE	PRESSURE RANGE (PSI)	CASE SIZE (IN)	PROTECTOR REQUIREMENTS	SNUBBER REQ'D

B. Pressure Gauge - Digital:
1. Manufacturers:
a. APG (Series PG10).
b. Ashcroft (Types 2074, 2174, and 2274).
c. Omega (DPG9000 Series).

2. Specifications:
    a. Digital pressure display with Bar graph and Backlighting.
    b. Case Size: 4.5 inches.
    c. Case Material: Stainless steel.
    d. Enclosure Rating: IP65, Weatherproof.
    e. Wetted materials: 17-4 SS, or 316SS.
    f. Socket size: 1/4 inches NPT.
    g. Operating Temperature: 14 – 140 degrees F.
    h. Accuracy: ±0.25% of full scale.
    i. Power source: 24 VDC loop power.
    j. Battery Life: >2000 hours.
    k. Menu driven configuration.
3. Schedule:

TAG NUMBER	SERVICE	PRESSURE RANGE (PSI)	CASE SIZE (IN)	POWER

2.5 ISOLATION DEVICES

A. Diaphragm Seal:
1. Manufacturers:
    a. Ametek.
    b. Ashcroft.
    c. Emerson Rosemount.
2. Materials:
    a. Lower housing: 316 stainless steel.
    b. Diaphragm material: 316 stainless steel.
3. Design and fabrication:
    a. Isolates instrument from process fluids which are corrosive or contain solids.
    b. Upper housing with bleed screw.
    c. Lower housing with flushing connection.
    d. Fill fluid:
        1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMNO4, FeCl, NaOH, and NaOCl.
        2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
    e. Process connections:
        1) Instrument: 0.25 inches female NPT.
        2) Process: 0.5 inches female NPT.
        3) PVC pipe applications: Use a socket weld connection.
4. Installed where specified or shown on Drawings.

B. In-Line Isolation Sleeve (Annular Seal) for non-Sludge or Scum applications:
   1. Manufacturers:
      a. Ametek.
      b. Red Valve.
   2. Materials:
      a. Body: 316 stainless steel.
      b. Flanges: 316 stainless steel.
      c. Flexible liner: Buna-N.
   3. Design and fabrication:
      a. Provide full 360 degree annular pressure sensor with flexible in-line sleeve.
      b. Sensor shall not restrict the process flow (non-intrusive).
      c. Seal shall have ANSI Class 150 flanges.
         1) Line size as shown on the Drawings.
      d. Instrument connection: 0.25 inches female NPT.
      e. Fill fluid:
         1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl2, KMNO4, FeCl, NaOH, and NaOCl.
         2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
      f. Pressure rating: To meet requirements of schedule.

C. Sludge or Scum Service Instrument Isolators:
   1. Manufacturers:
      a. Ashcroft, Inc. (Model 106).
      b. Or equal.
   2. Materials:
      a. Diaphragm: 316 stainless steel.
      b. Lower Housing: 316 stainless steel.
   3. Design and fabrication:
      a. Isolates instruments from process fluids which are corrosive or contain solids.
      b. Upper housing with bleed screw.
      c. Lower housing with flushing connection.
      d. Fill fluid:
         1) Utilize halocarbon fill for process applications involving strong oxidizing agents.
            a) Agents include but are not limited to: Cl_2, $KMNO_4$, FeCl, NaOH, and NaOCl.
         2) Utilize manufacturer's standard fill for other applications.
            a) Ensure fill is suitable for application temperatures.
      e. Process connections:
         1) 0.5 inches female NPT.
         2) Process: In-lined flanged, match line size

2.6 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
   1. Materials, unless otherwise specified, shall be as follows:
      a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
      b. Mounting brackets:

1) Standard: 316 stainless steel.
2) Highly corrosive areas: Aluminum.

c. Mounting plates, angles:
1) Standard: Carbon steel.
2) Corrosive areas: 316 stainless steel.

d. Instrument pipe stands:
1) Standard: Hot-dip galvanized 2 inches schedule 40, ASTM A106, Grade B carbon steel.
2) Corrosive areas: 316 stainless steel.

B. Tubing Support Angles and Brackets:
1. Any of the following materials are acceptable:
a. Aluminum support with dielectric material between support and tubing.
b. Type 316 stainless steel.
c. Fiberglass.

C. Tubing Tray or Channel:
1. Aluminum.
2. Provide dielectric material between tray or channel and tubing.

D. Provide handheld communicator compatible with all intelligent transmitters furnished.
1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

E. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Instrument Valves:
1. Orient stems for proper operation.
2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
3. Provide a minimum of 2 inches clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
a. When cool, reassemble the valves.
5. Support each valve individually.
a. The tubing system does not qualify as support for the valve.

D. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.

E. Keep foreign matter out of the system.

F. Remove all oil on piping and tubing with solvent before piping and tubing installation.

G. Plug all open ends and connections to keep out contaminants.

H. Threaded Connection Seals:

1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

I. Instrument Mounting:

1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
   a. Protection from heat, shock, and vibrations.
   b. Accessibility for maintenance.
   c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

SECTION 40 74 00
TEMPERATURE INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Temperature Transmitters.
2. Temperature Sensors.
   a. RTDs.
   b. Thermocouples.
3. Temperature Switches.
   a. Electro-Mechanical.
   b. Digital / Electronic.
4. Temperature Indicators.
   a. Thermometers.
   b. Digital / Electronic.
5. Thermowells.

B. The instruments specified in this Specification Section are the primary element components for the control loops which are specified in Specification Section 40 61 96 and shown on the Control System Drawings.

1. These instruments are integrated with other control system components specified under Specification Section 40 61 13 to produce the functional control system defined in the Contract Documents

C. Related Specification Sections include but are not necessarily limited to:

1. Section 40 61 13 - Process Control System General Requirements.
2. Section 40 61 96 – Process Control Descriptions.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Iron and Steel Institute (AISI):
   a. Type 316 Stainless Steel.
2. American Society of Mechanical Engineers (ASME):
   a. PTC 19.3, TW – 2016 Thermowells.
   b. B40.200, Thermometers, Direct Reading and Remote Reading.
3. ASTM International (ASTM):
   a. A182/A182M, Standard Specification or Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. E230/E230M-17 Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
   c. F316, Austenitic Stainless Steel.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 40 61 13 - Process Control Systems General Requirements.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 78 23 for requirements for:

a. The mechanics and administration of the submittal process.
b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 TEMPERATURE TRANSMITTER

A. Temperature Transmitters:

1. Manufacturers:
   a. Emerson Rosemount (3144).
   b. Endress + Hauser (Omnigrad S).
   c. Schneider Electric / Foxboro (RTT).
   d. Siemens (SITRANS T).
2. Materials:
   a. Housing: Aluminum.
3. Design and fabrication:
   a. Smart transmitter utilizing microprocessor based electronics.
   b. Input: RTD, thermocouple or millivolt, as specified in schedule.
   c. Signal Output: 4-20 mA DC signal linearly proportional to temperature.
   d. Optional Communication: HART.
   e. Power supply: 24 VDC Loop Power.
   f. Adjustable zero and span.
   g. Temperature limits:
      1) -20 to 180 degrees F (without digital display)
      2) -20 to 158 degrees F (with digital display)
   h. Humidity limits: 0 to 99% relative humidity.
   i. Damping: Adjustable between 0 and 60 seconds.
   j. D/A accuracy: ±0.02%.
   k. Transmitter accuracy (including linearity, repeatability, and hysteresis) shall be in accordance with the following:
      1) RTD (100 ohm platinum): ±0.18 degrees F (Range: -328 to 1022 degrees F).
      2) Thermocouple (Type E): ±0.36 degrees F (Range: -58 to 1832 degrees F).
      3) Thermocouple (Type J): ±0.45 degrees F (Range: -292 to 1400 degrees F).
      4) Thermocouple (Type K): ±0.45 degrees F (Range: -292 to 2501 degrees F).
      5) Thermocouple (Type N): ±0.72 degrees F (Range: -328 to 2372 degrees F).
      6) Thermocouple (Type R): ±1.08 degrees F (Range: 32 to 3214 degrees F).
      7) Thermocouple (Type S): ±0.90 degrees F (Range: 32 to 3214 degrees F).
      8) Thermocouple (Type T): ±0.45 degrees F (Range: -328 to 752 degrees F).
      9) Millivolt input: ±0.015 mV (Range: -10 to 100 mV).
   l. Stability:
      1) Any of the following drift limits are acceptable:
         a) Greater of: 0.1% of reading or 0.18 degrees F per 12 months.
         b) 0.05% of input reading plus 0.043% of span per 12 months.
         c) 0.05% of maximum span per 12 months.
   m. Ambient temperature effects (including digital, D/A conversion, and cold junction effects):
      1) Any of the following effects per 50 degrees F change are acceptable:
         a) One-half reference inaccuracy +0.18 degrees F.

b) Effects in accordance with the following inputs:
   (1) RTD (100 platinum): ±0.0027 degrees F.
   (2) Thermocouple (Type E): ±0.0072 degrees F +0.000043% of reading.
   (3) Thermocouple (Type J):
      (a) Readings >32 degrees F: ±0.0072 degrees F +0.00029% of reading.
      (b) Readings <32 degrees F: ±0.0072 degrees F +0.02% of absolute value of reading.
   (4) Thermocouple (Type K):
      (a) Readings >32 degrees F: ±0.0090 degrees F +0.00054% of reading.
      (b) Readings <32 degrees F: ±0.0090 degrees F +0.0002% of absolute value of reading.
   (5) Thermocouple (Type N): ±0.0090 degrees F +0.00036%.
   (6) Thermocouple (Type R):
      (a) Readings >392 degrees F: ±0.027 degrees F.
      (b) Readings <392 degrees F: ±0.038DegF - 0.0032% of reading.
   (7) Thermocouple (Type S):
      (a) Readings >392 degrees F: ±0.027 degrees F.
      (b) Readings <392 degrees F: ±0.038DegF - 0.0032% of reading
   (8) Thermocouple (Type T):
      (a) Readings >32 degrees F: ±0.009 degrees F.
      (b) Readings <32 degrees F: ±0.009 degrees F + 0.0036% of absolute value of reading.
   (9) Millivolt input: ±0.00025 Mv.

2.2 TEMPERATURE SENSORS

A. RTD's:
   1. Manufacturers:
      a. Emerson Rosemount.
      b. Endress + Hauser.
      c. Schneider Electric / Foxboro.
      d. Siemens.
   2. Materials:
      a. Sensor: Platinum (Pt100).
      b. Sheath:
         1) 900 degrees F maximum: Type 316 stainless steel.
         2) 1200 degrees F maximum: Inconel.
      c. Insulation: Ceramic or metallic oxide.
   3. Design and fabrication:
      a. 100 ohms at 0 degrees C.
      b. Spring loaded.
      c. Lead wire compensation: Three- or four-wire.
      d. Accuracy: ±0.5 degrees F or ±0.5% of measured temperature, whichever is greater.
      e. Sheath diameter: 1/4 inches.
         1) Ambient temperature: -40 to 185 degrees F.

B. Thermocouples:

1. Manufacturers:
    a. Emerson Rosemount.
    b. Endress + Hauser.
    c. Schneider Electric / Foxboro.
    d. Siemens.
2. Materials:
    a. Sheath:
        1) 1600 degrees F maximum: Type 304 or 316 stainless steel.
        2) 2100 degrees F maximum: Inconel.
    b. Insulation: Ceramic or metallic oxide.
3. Design and fabrication:
    a. Type: K.
    b. Spring loaded.
    c. Ungrounded.
    d. Sheath diameter: 1/4 inches.
    e. Lead wires: 20 AWG minimum.
    f. Color-coded wire insulation per ANSI MC96.1.
        1) Tolerance per ANSI MC96.1.
    g. Dual element.

2.3 TEMPERATURE SWITCHES:

A. Electro-Mechanical:
1. Manufacturers:
    a. Ashcroft (Series B).
    b. SOR (200 Series).
    c. United Electric (120 Series).
2. Design and fabrication:
    a. Housing: NEMA 4X (IP66).
    b. Reset function: Auto.
    c. Deadband: Adjustable.
    d. Deadband: <2% of span.
    e. Setpoints: Single.
    f. Switches: SPDT.
    g. Mounting: Direct.
    h. Ambient Temperature: -58 to 160 degrees F.
    i. Contact rating:
        1) >0.5 amp resistive at 125 VDC.
        2) >10 amp resistive at 120 VAC.
            (1) Switch accuracy: ±1% of span

B. Digital / Electronic:
1. Manufacturers:
    a. Endress + Hauser (Thermophant T).
    b. United Electric (ONE Series).
2. Design and fabrication:

a. Housing: NEMA 4X (IP66).
b. Design:
    1) Self-diagnostic.
    2) 4-20 mA loop power optional.
    3) Accuracy: ±0.5% of span.
    4) Repeatability: ±0.1% of span.
c. Programmable:
    1) Reset function:
    2) Deadband:
    3) Deadband: <2% of span.
    4) Setpoints: Single.
d. Switches: SPDT.
e. Mounting: Direct.
f. Ambient Temperature: -40 to 158 degrees F.
    1) With Display: 10 to 158 degrees F.
g. Contact rating:
    1) > 0.5 amp resistive at 125 VDC.
    2) > 10 amp resistive at 120 VAC.
        (1) Switch accuracy: ±1% of span

2.4 TEMPERATURE INDICATORS

A. Thermometer:
1. Manufacturers:
    a. Ashcroft (EI Series).
    b. Pyromation (Code BM01).
    c. U.S. Gauge / Ametek (Model BAC).
2. Materials:
    a. Case: 316 stainless steel.
    b. Ring: 316 stainless steel.
    c. Stem: 316 stainless steel.
    d. Thermowell: ASTM A182, F316 stainless steel.
    e. Bulb: AISI 316 stainless steel.
3. Design and fabrication:
    a. Type:
        1) Bimetallic for applications not exceeding 800 degrees F.
        2) Inert gas filled for applications exceeding 800 degrees F.
    b. Every angle case connection.
    c. Hermetically sealed case with external adjustment.
    d. Dial:
        1) Minimum 4-1/2 inches.
        2) White face.
        3) Black numbers and pointer.
    e. Thermometer well:
        1) Extension neck for insulated lines.
    f. Accuracy ±1% of full span.

g. Shatterproof glass.

B. Digital / Electronic.

1. Manufacturers:
   a. Endress + Hauser (Omnigrad M).
   b. U.S. Gauge / Ametek (Model DT).
2. Design and fabrication:
   a. Housing: NEMA 4X (IP66).
   b. Housing Material: Aluminum.
   c. Works with RTD or Thermocouple J or K
   d. Accuracy: ±1.8 degrees F
   e. Display Height: 0.5 inches.
   f. Display Window: Tempered glass.
   g. Display Resolution: 4 digits.
   h. Display Units: DEGF or DEGC, Selectable.
   i. Battery Life: 24 months.
   j. Ambient Temperature:
      1) RTD: -4 to 140 degrees F.
      2) J/K Thermocouple: 32 to 140 degrees F.
   k. Programmable.

2.5 THERMOWELLS:

1. Manufacturers:
   a. Emerson Rosemount.
   b. Endress + Hauser.
   c. Schneider Electric / Foxboro.
   d. Daily Thermetrics
   e. Ashcroft.
   f. SOR.
   g. United Electric (120 Series).
   h. U.S. Gauge / Ametek (Model DT).
2. Materials:
   a. Well: ASTM A182, F316 stainless steel.
   b. Head: Cast iron.
3. Design and fabrication:
   a. Constructed in accordance with ASME PTC 19.3, Part 3, Chapter 1, Paragraphs 8-19.
   b. Lagging extension sufficient to provide wrench clearance above lagging.
   c. Seal welded on applications where process pressure exceeds 450 psi.
   d. Test Thermowells shall be supplied with watertight cap and chain.

2.6 ACCESSORIES

A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.

1. Materials, unless otherwise specified, shall be as follows:

a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
b. Mounting brackets:
1) Standard: Carbon steel.
2) Corrosive areas: 316 stainless steel.
c. Mounting plates, angles:
1) Standard: Carbon steel.
2) Corrosive areas: 316 stainless steel.
d. Instrument pipe stands:
1) Standard: carbon steel.
2) Corrosive areas: 316 stainless steel.

B. Provide handheld communicator compatible with all intelligent transmitters furnished.
1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.

C. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install instrument mounting pipe stands level and plumb.

C. Keep foreign matter out of the system.

D. Threaded Connection Seals:
1. Use Tite-Seal or acceptable alternate.
2. Use of lead base pipe dope or Teflon tape is not acceptable.
3. Do not apply Tite-Seal to tubing threads of compression fittings.

E. Capillary Tubing:
1. Route capillary tubing in tubing tray.
2. Install capillary tubing with a 2 inches minimum bend radius which does not kink or pinch the capillaries.
3. Do not cut or disconnect at any point.
4. Coil excess capillary tubing and secure at the instrument.

F. Temperature Elements:
1. Assemble in the following sequence:
a. Remove temperature sensor sheaths and terminal blocks from the head and nipple assembly.
b. Connect nipple and head to thermowell installed in the pipe.
c. Insert sheath and terminal block until it seats in the thermowell.
d. Connect to the head.

G. Instrument Mounting:
1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.

3. Mount instruments level, plumb, and support rigidly.
4. Mount to provide:
    a. Protection from heat, shock, and vibrations.
    b. Accessibility for maintenance.
    c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

SECTION 40 78 00
PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panel mounted digital display.
2. Pilot devices:
   a. Selector switches.
   b. Pushbuttons.
   c. Indicating lights.
   d. Combination selector switch/indicator light.
   e. Potentiometer.
3. Relays
   a. Control relay.
4. Termination equipment:
   a. Terminal blocks.
   b. Fuse holders.
5. Power supplies:
   a. DC power supplies.
   b. Isolation transformers.
6. Voltage surge protection devices.

B. Related Sections include but are not necessarily limited to:

1. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits.
2. Section 40 61 13 - Process Control Systems General Requirements.

1.2 REFERENCES

A. Referenced Standards:

1. The International Society of Automation (ISA):
   a. S18.1, Annunciator Sequences and Specifications.
   b. ANSI/ISA-12.02.02-2014, Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

B. Miscellaneous:

1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Control Drawings for intrinsically safe systems:
      1) Print on 8-1/2 x 11 inches sheets.

2) In accordance with recommendations of ANSI/ISA-12.02.02-2014.
3) One control drawing per sheet.
4) Identify model numbers of both the associated apparatus and the intrinsically safe apparatus.
5) Include wiring diagram showing interconnections of the intrinsically safe apparatus and the associated apparatus.
6) Provide entity parameters for both the associated apparatus and the intrinsically safe apparatus.
7) Identify line of demarcation between classified (hazardous) and unclassified (nonhazardous) locations and identify equipment that is installed in each location.
8) Identify hazardous areas by class, groups, and divisions.
9) Show maximum nonhazardous location voltage that may be used with the associated apparatus.
10) Include any specific conditions that are necessary to maintain the intrinsic safety protection.

B. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

2.2 PILOT DEVICES

A. Selector Switches:

1. Manufacturers:
   a. Eaton.
   b. Rockwell Automation (Allen-Bradley)
   c. Schneider Electric
   d. GE].
   e. Siemens
2. Design and fabrication:
   a. Heavy-duty type.
   b. Oiltight.
   c. Rotary cam units conforming to NEMA ICS 2-216.22.
   d. Mounting hole: 30.5 mm.
   e. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified
   f. UL listed.
   g. Maintained contact type.
   h. [Lever]type operators.
   i. Black colored operators.
   j. Designed with cam and contact block with approximate area of 2 inches SQ.
   k. Contact block requirements:

1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
2) Wet or outside locations: Hermetically sealed contact blocks.

B. Pushbuttons:

1. Manufacturers:
   a. Eaton.
   b. Rockwell Automation (Allen-Bradley)].
   c. Schneider Electric].
   d. GE.
   e. Siemens .
2. Materials:
   a. Backing diaphragm: Buna-N.
3. Design and fabrication:
   a. Heavy-duty type.
   b. Oiltight [
   c. Conforming to NEMA ICS 2-216.22.
   d. Mounting hole: 30.5 mm.
   e. Diaphragm backed.
   f. UL listed.
   g.
   h. Non-illuminated type:
      1) Momentary contact with necessary contact blocks.
      2) Molded, solid color melamine buttons.
      3) [Standard flush] [Long, mushroom] operators with [full] [half] [no] shroud.
      4) Greencolored buttons for START or ON and greencolor for STOP or OFF.
      5) Appropriate contact blocks to fulfill functions shown or specified.
   i. Contact block requirements:
      1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
      2) Wet or outside locations: Hermetically sealed contact blocks.
      3) [Manufacturer furnished] Legend plate marked per Contract Documents.
   j. Illuminating type:
      1) Momentary contact with necessary contact blocks.
      2) Serves as both pushbutton control and indicating light.
      3) Green colored lenses for start or on and red for STOP or OFF.
      4) Resistor-type full voltage light unit with lens and panel gasket.
      5) Legend plate marked per Contract Documents.
      6) Appropriate contact blocks to fulfill functions shown or specified.

C. Indicating Lights:

1. Manufacturers:
   a. Eaton.
   b. Rockwell Automation (Allen-Bradley) .
   c. GE.
   d. Siemens .
2. Design and fabrication:
   a. Heavy duty

b. Oiltight
c. Type allowing replacement of bulb without removal from control panel.
d. LED.
e. UL listed.
f. 24 V lamp.
g. [
h. Nominal 2 inches SQ face.
i. Mounting hole: 30.5 mm.
j. Push-to-test indicating lights.
k. Plastic lens.
l. Color code lights as follows:
1) Green: ON or running; valve open.
2) Amber: Standby; auto mode; ready.
3) Red: OFF or stopped; valve closed.

D. Potentiometer:
1. Manufacturers:
a. Eaton.
b. Allen-Bradley.
2. Design and fabrication:
a. Heavy-duty, NEMA type.
b. Mounting hole: 30.5 mm.
c. UL listed.
d. Linear adjustment through 0-1000 ohms with 1% resolution.
e. 3-wire interface.
f. Dial plate with 0-100% scale.
g. Panel mounted.
h. One-turn adjustment knob.

2.3 RELAYS

A. Control Relays:
1. Manufacturers:
a. Idec.
b. TE Connectivity).
c. Rockwell Automation (Allen-Bradley) .
d. Eaton .
e.
2. Design and fabrication:
a. Plug-in general purpose ice cube relay.
b. Bladeconnector type.
c. Switching capacity: 10 A.
d. Contact material: Silver cadmium oxide.
e. Provide relays with a minimum of 4 DPDT contacts.
f. Coil voltage: 24 VDC.
g. Relay sockets are DIN rail mounted.
h. Internal neon or LED indicator is lit when coil is energized.
i. Clear polycarbonate dust cover with clip fastener.

j. Check button.
k. Temperature rise:
1) Coil: 85 degrees F max.
2) Contact: 65 degrees F max.
l. Insulation resistance: 100 Meg min.
m. Frequency response: 1800 operations/hour.
n. Operating temperature: -20 to +150 degrees F.
o. Life expectancy:
1) Electrical: 500,000 operations or more.
2) Mechanical: 50,000,000 operations or more.
p. UL listed.

2.4 TERMINATION EQUIPMENT

A. Terminal Blocks:
1. Manufacturers:
a. Phoenix Contact .
b. Rockwell Automation (Allen-Bradley) .
c. Weidmuller
2. Design and fabrication:
a. Modular type [feed-through] with screw compression clamp.
b. Screws: Stainless steel.
c. Current bar: Nickel-plated copper allow.
d. Thermoplastic insulation rated for -40 to +90 degrees C.
e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
f. Install end sections and end stops at each end of terminal strip.
g. Install machine-printed terminal markers on both sides of block.
h. Spacing: 6 mm.
i. Wire size: 22-12 AWG.
j. Rated voltage: 600 V.
k. Din rail mounting.
l. UL listed.
3. Standard-type block:
a. Rated current: 30 A.
b. Color: Gray body.
4. Bladed-type block:
a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
b. Rated current: 10 A.
c. Color:
1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
2) Foreign voltage entering enclosure: Orange body, orange switch.
5. Grounded-type block:
a. Electrically grounded to mounting rail.
b. Use to terminal ground wires and analog cable shields.
c. Color: Green and yellow body.

B. Fuse Holders:

1. Manufacturers:
    a. Phoenix Contact.
    b. Rockwell Automation (Allen-Bradley).
    c. Weidmuller.
    d. Eaton.
2. Design and fabrication:
    a. Modular-type with screw compression clamp.
    b. Screws: Stainless steel.
    c. Current bar: Nickel-plated copper alloy.
    d. Thermoplastic insulation rated for -40 to +105 degrees C.
    e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
    f. Blocks can be ganged for multi-pole operation.
    g. Install end sections and end stops at each end of terminal strip.
    h. Install machine-printed terminal markers on both sides of block.
    i. Spacing: 9.1 mm.
    j. Wire size: 30-12 AWG.
    k. Rated voltage: 300 V.
    l. Rated current: 12 A.
    m. Fuse size: 1/4 x 1-1/4.
    n. Blown fuse indication.
    o. DIN rail mounting.
    p. UL listed.

2.5 POWER SUPPLIES

A. DC Power Supplies:

1. Manufacturers:
    a. Sola Hevi-Duty.
    b. Phoenix Contact.
    c. Rockwell Automation.
2. Design and fabrication:
    a. Converts 120 VAC input to DC power at required voltage.
    b. DIN rail mount with enclosure (i.e., not open frame).
    c. Switching type.
    d. Provide redundant 24VDC modules with diode redundancy module for automatic switchover to standby module on failure of primary module.
    e. Hardwire module fault dry contact to associated PLC input for alarm at Plant SCADA.
    f. AC input: 120 VAC, 60 Hz.
    g. Efficiency: Minimum 86%.
    h. Rated mean time between failure (MTBF): 500,000 hours.
    i. Voltage regulation:
        1) Static: Less than 1.0% V_{out}.
        2) Dynamic: ±2% V_{out} overall.
    j. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
    k. Overload, short circuit and open circuit protection.
    l. Temperature rating: 0 to 60 degrees C full rated, derated linearly to 50% at 70 degrees C.
    m. Humidity rating: Up to 90%, non-condensing.

n. LED status indication for DC power.
o. UL listed.

B. Isolation Transformers:

1. Manufacturers:
   a. Topaz Noise Suppressor Noise Isolator.
   b. MGE UPS Systems, Topaz T1.
2. Design and fabrication:
   a. Protects sensitive electronic equipment from electrical noise.
   b. Common-mode noise attenuation: 146 dB at 0.0005 pF coupling capacitance.
   c. Normal-mode attenuation: 60 dB.
   d. Input voltage range: ±10% of rated.
   e. Regulation: 3.5% or less from full-load to no-load.
   f. Dielectric strength: 2,500 VAC minimum.
   g. Harmonic distortion: 1% maximum.
   h. Electromagnetic interference: 0-1 gauss maximum at 18 inches.
   i. UL listed.

2.6 VOLTAGE SURGE PROTECTION DEVICES

A. See Specification Section 26 43 13.

2.7 PANEL MOUNTED DIGITAL DISPLAY

A. Manufacturer:

1. Automation Direct C-More
2. Red Lion [PAX] [PAX2].
3. Omron K3GN.
4. Precision Digital [Trident] [ProVu].

B. Design and Fabrication:

1. Type of Display: LCD, Reflective or Red/Green LED Backlighting.
   a. Display color change capability at setpoint output.
   b. Minimum 0.4 inch display digit height requirement.
2. Power input: 24 Vdc.
3. Front Panel: IP65/66 certified, NEMA 4X for indoor use.
4. Input Signal: Ethernet.
5.
6. Communication Protocol: To match process signal.
7. Operating Temperatures: 0 - 65 Degrees C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount adder/subtractors, multiplier/dividers, square root extractors, transducers and program timers on separate subpanel in control panel.

C. Instrument Air Compressors:

1. Pipe condensate outside panel to nearest floor drain.
2. Mount compressors with rubber vibration isolators.

END OF SECTION

DIVISION 41

MATERIAL PROCESSING AND HANDLING EQUIPMENT

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SECTION 41 22 13
OVERHEAD BRIDGE CRANE

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. Contractor shall be responsible for design, fabrication, shipping, erection, and testing of the new bridge crane and alignment or replacement of the existing crane rails.

1. The new crane shall match all the same functionality of the existing crane but add an additional 6 inches of lift height.

B. Crane Classification:

1. In accordance with CMAA #74I, hoist shall be rated for Class C or better service, taking into account the minimum operational requirements, and intended modes of operation as described within this document.

C. Crane Usage:

1. Crane is located in an unconditioned indoor environment near Pocatello, ID
2. Crane must be designed to be operable year-round.
3. Crane must be capable of frequently lifting and transporting at rated speed loads up to and including rated capacity over a 24 HR per day; seven (7) day per week; 365 calendar day schedule.
4. Crane must be capable of statically lifting in place a load of up to 125 percent of rated main hook capacity (anticipated actual load of up to 5 tons).
5. Crane must be designed for frequent lifts up to 100 percent of rated load.
6. All components of the new bridge crane, including but not limited to structural members, controls, electrical components, brakes, and hoist motors must be designed to provide reliable service under these loading conditions.
7. Following any heavy usage as noted above, the new bridge crane will go into standby service to be periodically utilized to unload equipment, install, or handle other equipment at the site.

1.2 REFERENCES

A. General

1. The publications listed below form a part of this specification to the extent referenced. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.
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.

B. American Institute of Steel Construction (AISC)

1. AISC S329, Allowable Stress Design Specification for Structural Joints Using ASTM A325 or A490 Bolts
2. AISC RCSC, Specification for Structural Joints Using High-Strength Bolts
3. AISC Steel Construction Manual

C. American Society of Civil Engineers (ASCE)/ Structural Engineering Institute (SEI)

1. ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures

D. American Society of Mechanical Engineers (ASME)

1. ASME B30.10, Hooks

E. ASTM International (ASTM)

1. ASTM A36, Standard Specification for Carbon Structural Steel
2. ASTM A992, Standard Specification for Structural Steel Shapes
3. ASTM A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
4. ASTM F3125, Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

F. American Welding Society (AWS) / American National Standards Institute (ANSI)

1. AWS/ANSI D1.1, Structural Welding Code-Steel
2. AWS/ANSI D14.1, Welding Industrial and Mill Cranes and Other Material Handling Equipment

G. Crane Manufacturers Association of America (CMAA)

1. CMAA 74, Specification for Top Running Bridge and Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoist Gantry Type Multiple Girder Electric Overhead Traveling Cranes

H. Hoist Manufactures Institute (HMI)

I. International Organization for Standardization (ISO)

1. ISO 9001, Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing
2. ISO 9002, Quality Systems - Model for Quality Assurance in Production, Installation and Servicing

J. National Electrical Manufacturers Association (NEMA)

1. NEMA MG 1, Motors and Generators
2. NEMA 250, Enclosures for Electrical Equipment

K. Institute of Electrical and Electronics Engineers (IEEE)

1. National Electrical Safety Code (NESC)

L. National Fire Protection Association (NFPA)

1. NFPA 10, Standard for Portable Fire Extinguishers
2. NFPA 70, National Electrical Code (NEC)

1.3 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00 and as specified herein.

1. Submittals for approval shall be provided for the following categories or subcomponents of the bridge crane. Detailed requirements follow below.
   a. Bridge with end trucks
   b. Hoist
   c. Trolley
   d. Trolley rail or beam details
   e. Hook
   f. Chain
   g. Electric motor data
   h. Coatings
   i. Electrification system, and pendants
   j. Schematics and wiring diagrams

k. Factory and Field Test Results

2. The Contractor shall provide complete catalog information, descriptive literature, materials of construction; and specifications on the bridge drive system, end trucks, runway stops, wheels, shafting, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, pendant control, and accessories.
3. All bills of materials and materials of construction shall include ASTM designations.
4. Equipment Drawings:
   a. Bridge construction drawing showing all materials, components, complete details of all connections, and outline dimensions with materials of construction including end trucks. Shop drawings shall clearly distinguish between shop welds, field welds, and/or bolts.
   b. Hoist drawings showing the general arrangement of all components, clearances, and dimensions and assemblies. Show dimensional outline of hoist and hoist cross-sectional assembly drawings with materials of construction.
   c. Trolley drawings showing the general arrangement of all components, clearances, and dimensions and assemblies. Show dimensional outline of trolley and track cross-sectional assembly drawings with materials of construction.
   d. Assembly drawing of the bridge, hoist, and trolley, showing the general arrangement of all components, clearances, dimensions, and assembly of the complete bridge crane system.
   e. Additional gearing mechanism cross-sectional assembly drawings with materials of construction.
   f. Electrification system, and pendant
   g. Hook details
   h. Chain details
   i. Bumper details
   j. Brake details
   k. Make, model, weight, and horsepower of each component assembly
5. Coating information in accordance with Section 09 96 00 including:
   a. Coating procedure
   b. Factory finish system for Electrical components in accordance with Section 09 96 00
   c. Manufacturer's Certification of Compliance that the factory finish system is in compliance with the requirements specified herein
6. Calculations:
   a. Bridge, trolley and hoist design calculations including all wheel loads Structural calculations prepared, signed, and stamped by a Civil or Structural Engineer currently registered in the State of Idaho, shall be submitted for review and approval.
   b. Drive train calculations
   c. Chain sizing calculations
   d. All non-structural calculations shall be prepared, signed, and stamped by a registered professional engineer currently registered in the State of Idaho, shall be submitted for review and approval.
7. Electrical Data:
   a. Total connected load including all accessories, amperes at 480 volts, kVA and power factor
   b. Maximum expected operating loads including all accessories, amperes at 480 volts, kVA and power factor
   c. Electric motor data for all motors, as specified in Section 26 05 09, Motors
   d. Electrical schematics and internal point-to-point and external wiring diagrams
   e. Power and control wiring diagrams, including terminals and numbers

f. Power and Control Interconnection diagrams showing wiring interconnection between all system and remote components
g. Control panel elevation drawings showing construction and placement of operator interface device and other elements
h. Motor nameplate data in accordance with NEMA MG 1, including any motor modifications

8. Welding Procedures and Qualifications
   a. Weld map
   b. Welding Procedure Specifications (WPS)/Procedure Qualification Record (PQR)
   c. Welding Performance Qualifications (WPQ)
   d. Non-Destructive Testing (NDT) Procedures, and testing personnel qualifications for shop and field testing shall be submitted for shop and field welding.
9. Weld repair procedures
10. Stainless steel pickling and passivation procedure.
11. Seismic Qualification:
    a. Seismic qualification for cranes by analysis shall be prepared, signed and stamped by a Civil or Structural Engineer currently registered in the State of Idaho
    b. Seismic qualification for cranes by test shall be performed by a testing agency acceptable to the authority having jurisdiction, and testing report shall be submitted for review and approval.
    c. Use of an alternative to analysis or test shall be based upon nationally recognized procedures acceptable to the authority having jurisdiction.
12. Certified Material Test Reports (MTRs) of major crane components
13. Project-specific Quality Assurance Plan (QAP)
14. Process crane manufacturer's qualifications
15. Proposed Installation Sequence and Outage Plan
16. Installation, Operations and Maintenance:
    a. Operation and Maintenance Data: Manual shall cover all equipment, including:
       1) Bridge, Trolley and hoisting equipment
       2) Hoist drive units
       3) Crane controls
    b. Special shipping, storage and protection, and handling instructions
    c. Manufacturer's printed installation instructions
    d. Manufacturer's Certificate of Proper Installation
17. Spare Parts and Special Tools:
    a. The Contractor shall obtain from the equipment manufacturers a list of the suggested spare parts for all items such as motors, drives, and speed reducers subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, and bearings.
    b. List of suggested spare parts to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
    c. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
18. Factory and Field Testing:
    a. Factory and Field Plan and Procedures, submitted 60 working days prior to start of tests
    b. Factory Test Report
    c. Field Test Reports:
       1) Post-erection inspection
       2) Operational tests

3) No load test
4) Load and hook tests

1.4 MANUFACTURER'S QUALIFICATION

A. The supplier shall have manufactured bridge cranes of similar design that have been in service for at least 10 years.

B. The Contractor shall bear the burden of proof that the proposed manufacturer and all manufacturing facilities meet the experience requirements. The Contractor shall submit documentation to demonstrate that the manufacturing facilities listed meet the experience requirements hereinbefore specified.

1.5 QUALITY ASSURANCE

A. The Contractor shall ensure that the manufacturer is actively controlling and supervising the design, machining, fabrication, assembly and testing processes whenever it is using its own facilities or subcontracted facilities in the design, machining, fabrication, assembly and testing of the equipment, including the publication and adherence to a corporate Quality Assurance Plan (QAP).

B. The Contractor shall submit a project-specific QAP to the Engineer for approval. The QAP shall be in accordance with ISO 9001 and ISO 9002. All aspects of design, manufacturing and testing of the crane shall be covered by the project-specific QAP. Additionally, the QAP shall address how the Contractor plans on ensuring that his or her manufacturers and suppliers are adhering to the requirements of the specifications and the QAP.

C. The Contractor shall comply with CMAA 74.

D. The Contractor and his or her manufacturers and suppliers shall maintain complete records for tracing materials, products, and manufactured parts.

E. At all times during business hours, the Engineer shall have access to the offices and places of manufacture of the Contractor and his or her manufacturers and suppliers for the purposes of auditing the QAP.

1.6 SAFETY AND REGULATORY REQUIREMENTS

A. Safety Requirements:

1. All equipment furnished under the contract shall comply with the Safety and Health Regulations of the Bureau of Labor Standards of the United States Department of Labor. All rotating or moving equipment shall be guarded in metal safety enclosures in compliance with these safety orders.

1.7 UNIT RESPONSIBILITY

A. The work requires that the Bridge Crane, trolley and hoist, complete with all accessories and appurtenances, be the end product of one responsible system manufacturer or responsible system supplier.

B. The Contractor shall identify an entity, if not the Contractor, who shall have overall technical coordination and unit responsibility for ensuring that all furnished equipment shall operate as a single functioning system.

C. The entity having overall unit responsibility shall coordinate all systems. Unless otherwise indicated, the Contractor shall obtain each system from the supplier of equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions indicated without altering or modifying the Contractor’s responsibilities under the Contract Documents. The Contractor shall furnish equipment systems as specified herein.

D. The duties of the entity having overall unit responsibility shall also include review of all sub-vendor submittals prior to their submittal to the Engineer. Particular attention shall be given to the integration of all sub-vendor components, logic, and interfaces in the submittals.

1.8 INSPECTIONS

A. Upon request by the Owner, the Contractor shall submit a manufacturing schedule.

B. The Contractor shall give the Owner's representative access to all Contractor and subcontractor facilities, during working hours, as is reasonable and necessary to determine the equipment to be supplied conforms to design, including specifications and drawings. The Owner's representative shall be allowed to observe all manufacturing processes. The Contractor and subcontractors shall furnish all the necessary apparatus, labor, and other facilities for the safe and convenient performance of inspections without cost to the Owner.

C. When requested by the Owner, the Contractor shall furnish additional information as may reasonably be required regarding the character of the materials and the progress of their procurement, including copies of invoices, bills of lading, and shipping lists on all articles and materials for use on the work.

D. Unidentified materials shall not be used in the Contractor's work, including work by subcontractors.

E. If witnessing of a test by the Owner is required, the test shall be considered a Hold Point unless waived by the Owner, and the Contractor shall notify the Owner of the test, two weeks prior to the test.

F. Neither inspection, waiving of inspection, nor the Owner's acceptance of the equipment shall relieve the Contractor of his or her obligation to furnish equipment in accordance with the specifications and drawings.

G. No equipment shall be shipped until all test reports and certifications have been approved by the Owner.

1.9 PREPARATION FOR SHIPMENT

A. The manufacturer shall prepare all equipment for shipment in such a manner as to protect it from damage in transit, and the Contractor shall be responsible for any and all damage due to improper preparation or loading for shipment.

B. All equipment shall be securely boxed or crated and prepared for long-term outdoor storage of up to 2 years.

C. The manufacturer shall securely box or crate all equipment, or shall mount equipment on pallets and support it in a manner that will prevent damage during shipment and subsequent storage. Equipment shall be packaged so as not to rub or contact other equipment.

D. When it is necessary to disassemble components for shipping, all uncoated machined surfaces to be exposed in such disassembly shall be coated with a suitable, easily removable, rust-preventive compound before shipping.

E. Equipment subject to deterioration due to moisture and dust shall be enclosed in heavy-duty, polyethylene envelopes together with dehumidifiers, to provide complete protection.

F. The manufacturer shall plug or cap all threaded openings with adequate thread protectors. All exposed process flanges shall have a plywood or equivalent type shipping cover, fabricated to match flange size and firmly attached to flange, to exclude foreign matter and prevent flange face damage.

G. Prior to shipment, the manufacturer shall mark and match mark all parts subject to disassembly for identification. Match marking information shall be submitted in the operation and maintenance manual.

H. Manufacturer shall ensure that each individual piece of equipment shall bear a stainless steel nameplate attached with stainless steel screws, upon which there shall be engraved the following information:

1. Manufacturer's name or trademark
2. Manufacturer's model and serial number
3. Equipment size and load rating

I. The manufacturer shall attach stainless steel warning plates with stainless steel screws to the equipment at all locations where metric bolting is used. Each plate shall have engraved on it a warning that metric bolting is used at the location identified on the plate.

J. After the equipment has been prepared for shipping, each shipping unit shall be plainly marked by stencil or equivalent with the contract number, the schedule and item number, the piece mark number, weight, lifting points, and center of gravity.

K. Weighing: The Contractor and/or manufacturer shall weigh the finished shipping assembly of each major item and shall report the weights, exclusive of boxes, crates, or pallets, to the Owner.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handling and shipping from the factory to the site shall be the Contractor's responsibility

B. All components which may be subject to damage from vibration or jarring during shipment shall be securely blocked or otherwise supported in a manner which will prevent damage. Ground shipment shall be made in trucks or "shock control" type railway cars.

C. All mechanical and electrical equipment shall be coated, wrapped and otherwise protected from precipitation, drippings of any sort, dust, dirt, mud, flood and condensed water vapor during shipment and while installed in place during construction. The protective coverings shall remain in place until the work areas are substantially free of all construction dust and debris.

D. Any components that are furnished under the contract but not required to be installed as part of the work shall be delivered to the facility. The Contractor shall submit, at least 30 days in advance of the equipment transfer, the dimensions and weight of each box or package containing the components.

E. The Contractor shall submit instructions and lubricants for dry, outdoor storage of components for a 2-year period as specified herein. Storage procedures shall be submitted to the Engineer for review prior to shipment of equipment.

F. All equipment, material and spare parts shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.

G. The Contractor shall submit, at least 30 days in advance of the equipment transfer, the dimensions and weight of each box or package containing the components.

H. The Contractor shall properly protect all parts so that no damage or deterioration will occur for up to 2 year from the time of shipment until installation is completed and the units and equipment are ready for operation.

I. The Contractor shall properly protect all equipment and parts against any damage for up to 2 year at the site.

J. The Contractor shall not dismantle factory-assembled parts and components for shipment unless permission is received in writing from the Owner.

K. The Contractor shall protect finished surfaces of all exposed-drive couplings by wooden blanks, strongly built and securely bolted thereto.

L. The Contractor shall properly protect finished iron or steel surfaces that are not painted to prevent rust and corrosion; and to maintain protection until operation.

1.11 GUARANTEE

A. The guarantee for all work, including materials, articles and equipment furnished by the Contractor . The warranty period shall be 5 years from the start of beneficial use by the Owner. The Contractor shall furnish a manufacturer’s extended warranty for the warranty period that is not covered by his or her performance bond.

1.12 MAINTENANCE

A. Spare Parts

1. The manufacturer shall furnish a full list of spare parts for the equipment for the plant. These spare parts are the minimum required by the Owner and shall be as listed in this section. This spare parts list shall be part of the operation and maintenance manual.
2. The manufacturer shall furnish all spare parts including gaskets, seals and belts, with rubber or rubber like components that age in sealed, airtight transparent containers, with the contents clearly labeled, including the date of packaging.
3. The manufacturer shall wrap all spare parts in waterproof packages suitable for export service. Each individual package is to be labeled with the description and part number. Packages shall be contained in sturdy wooden crates labeled with the description and part number of each package within and stored in a location designated by the Engineer. Storage shall be the responsibility of others.
4. The manufacturer shall furnish a two-year supply of all grease and lubricants, including two grease guns.
5. In addition to the spare parts listed, the manufacturer shall submit a list of all available spare and replacement parts.

PART 2 - PRODUCTS

2.1 GENERAL

A. The Contractor shall design, fabricate, deliver and install a bridge crane as specified herein.

B. The crane shall be single main hoist, bridge crane assembly designed as specified herein.

1. Bottom Running single girder electric overhead traveling crane shall be designed, manufactured and tested per CMAA 74
2. The bridge crane design and installation shall meet all the applicable local, state and federal laws and OSHA regulations having jurisdiction.
3. The crane service class shall be clearly indicated by the manufacturer at the time the crane shop drawings are submitted.
4. The crane shall be designed, manufactured, installed and tested to meet the appropriate service conditions based on the particular application.

C. All materials and parts used in the manufacture of the crane components shall be standard products utilized by manufacturers regularly engaged in the fabrication of complete and totally functional bridge crane and hoists. This shall include any necessary ancillary equipment.

D. Previously used equipment and materials are not permitted for the bridge, trolley and hoist. The existing crane rail can be reused if it is aligned to meet the requirements defined in CMAA 74.

E. All components must be designed and arranged in order to minimize the duration and the extent of the disassembly required for inspection, cleaning, and maintenance. Removable cover plates shall have quick-release fasteners and, where feasible, be hinged such that they can be easily opened and closed.

F. All components, which may present a risk to the safety of the operating or maintenance personnel, must be protected by an appropriate removable metallic guard. Where guarded components require frequent visual inspections, guards shall be constructed of mesh or other suitable materials to the extent feasible without compromising weather protection.

G. Shear blocks must be used for the assembly of mechanical components such as motors, reducers, brakes, pillow blocks, etc. in order to ensure permanent alignment and to facilitate assembly.

H. Guards shall be installed on all accessible areas of the crane to prevent contact with live electrical conductors. Areas requiring frequent visual inspections shall be fitted with guards constructed of mesh or other suitable material.

I. Clearance around electrical equipment must meet the most stringent specifications and codes such as the NFPA 74, NEC, and NESC.

J. The Contractor must also plan for and install on various pieces of the equipment lifting lugs and other items necessary for the handling and assembly of the crane. Lifting lugs shall be installed in the shop prior to shipment. Design shall be by a licensed engineer and installation shall be by a certified welder.

K. Lifting lugs shall be marked with their capacity.

L. All crane components that must be field assembled shall be clearly marked or stamped with the center of gravity and weight.

2.2 MANUFACTURERS

A. Manufacturer's Reference

1. Crane manufacturers: Specifications are based on equipment identified herein by manufacturer's name and model to establish minimal acceptable standards of quality, features, performance and construction.
   a. Washington Crane & Hoist
   b. Whiting Corporation
   c. Virginia Crane
   d. Morgan Crane
   e. Or equal

2.3 DESIGN REQUIREMENTS

A. General

1. The bridge crane shall be designed as girder bridge type with motor-operated hoist, manually operated trolley and manually operated bridge.
2. Crane capacity, CMAA service class, crane and building dimensions, lift requirements and travel and lift speed shall be as shown on the drawings
3. Manual trolley and hoist motion shall be controllable from the floor. Hoist control shall be by pendant
4. All bridge support systems, including wheels, bearings and shafts, as applicable, shall not be adversely affected, in any case, upon remaining in an idle state for 30 consecutive days, with further direction for operation after a longer period.
5. Bridge drive shall be manually operated type and controllable from the motor floor (Elevation 4453.0ft).
6. Structural calculations for hoist, trolley, bridge and connections shall include, but not be limited to, weight of complete crane, payload (rated load), number of cycles, camber and deflection, inertial effects due to motion, skewing load, and seismic loads for load carrying members and joints. Loads shall be combined to obtain a worst case bending stress on the bridge beam considering different trolley positions and loading conditions.
7. Design, fabrication, and inspection of structural components shall be in accordance with AISC Steel Construction Manual.
8. Vibration and Overloads
   a. The design of the equipment must ensure that for all operations where vibrations may occur, the behavior of the equipment remains stable and safe. Particular attention shall be given to electrical connections and terminations which are subject to vibration. In no case will wire nuts or other types of terminations or connectors be allowed which are not rated for vibration loading.
   b. The bridge, trolley and hoist must be designed such that all normal operations may be performed without any uncontrolled or "jerking" motion or overload on the equipment.
9. Design Life of Equipment
   a. All equipment covered by this specification, with the exception of wear and tear items and items that have an inherently shorter design life, shall be designed to provide safe and reliable operation for a minimum design life of 50 years. The Owner shall confirm the minimum design life based on the approach taken. Moreover, each mechanical

component must be designed for a useful functioning life which meets the Owner's service expectations. The overall design of the crane must be such that no adverse effect comes from the equipment remaining at rest for a long period of time followed by a period of near-continuous activity where the hoists may be operated frequently at up to rated load over an extended period. This includes avoiding any damage, deterioration, or reduction in the useful life of the equipment or its components.

10. Verification of dimensions and drawings
    a. The Contractor shall verify all dimensions shown on the existing drawings and physical dimensions that relate to existing runway
    b. Horizontal and vertical clearances around all equipment shall be independently verified in the field. With the exception of the increase max hook height, the range of motion of the new crane should remain the same as the existing crane. Where additional lifting height is required, Contractor shall accomplish this with the minimum additional crane height.
11. Climatic Conditions
    a. The crane and all its components shall be designed for outdoor use in an area where the outdoor environmental conditions may vary from approximately --33°F to 104°F (based on metadata from Pocatello, ID) and an environment of up to 50% relative humidity. The equipment shall be designed to operate satisfactorily at the extremes of the historical outdoor temperature range and during periods of inclement weather including windy conditions and precipitation events.

B. Materials

1.	Bridge Beams	Steel, ASTM A36 or A992
2.	End Trucks	Steel, ASTM A36
3.	Trolley	Steel, ASTM A36
4.	Wheels	Forged steel, ASTM A350
5.	Hooks	Forged steel, ASTM A572 Grade 50 or A255 Grade D

C. Crane Foundation

1. The crane support columns and beams are existing. The Contractor shall perform a survey to verify all dimensions and clearances, including but not be limited to, elevation, span, level and parallelism, and size and condition of the existing anchor bolts in field prior to erection and take responsibility for proper fitting and operation of equipment.

D. Bridge

1. Bridge girders shall be constructed from A36 or A992 welded box sections or beams. Girder shall be notched at ends and bolted to top of end trucks with horizontal connection plate utilizing shear rings to absorb horizontal shear forces and to maintain squareness. No 'in shear" connections between girders and trucks will be allowed.
2. Crane bridge shall be single girder bottom running type. Crane girders shall be designed to resist all vertical, lateral, longitudinal, and torsional forces combined as specified in CMAA 74.
3. Trucks shall be securely attached to bridge girders with turned bolts. All holes shall be drilled and reamed for matched fit before final assembly and welding. Connections in vertical plane shall be designed and constructed to keep entire bridge structure square and aligned under all operating conditions. End connections shall be made with high-strength bolts in accordance with CMAA 74.
4. The Contractor shall furnish and install end stops and accessories on the trolley rails designed to withstand the impact imposed by stopping of a fully loaded hoist trolley. The end stops shall be securely anchored and positioned to protect adjacent construction, materials, equipment, or similar obstructions
5. End trucks shall be designed in accordance with CMAA 74.

6. Bridge end trucks shall be constructed of welded box shapes, formed into a rigid rectangular housing.
7. Wheel assemblies shall consist of flat tread, double-flanged, high-quality forged steel wheels, having anti-friction bearing assemblies with whole wheel assembly readily removed for easy repair. Drive wheels shall have rotating axles; idler wheels may be of fixed axle type. Bridge trucks shall have ball or roller bearings. Entire truck shall be machined as a unit to ensure perfect alignment. Provision shall be made to prevent drop of more than 1 inch in case of axle failure.
8. Bridge trucks shall be 2-wheel design. Wheels shall be designed to carry maximum wheel load under normal operating conditions without undue wear. Diameter shall not be less than that shown for maximum load in CMAA 74. Wheel treads and flanges shall be rim toughened to between 320 and 360 Brinell hardness number. Bridge wheels shall be double-flanged. Bridge wheels shall have straight treads sized to operate on the existing rails. Wheel shall be equipped with heavy-duty anti-friction bearings – no bushings shall be allowed.
9. The bridge drive shall be in accordance with the CMAA service classification specified herein, and shall consist of dual drives, with one drive connected to one wheel of each end truck. Drive mechanism shall be designed so that travel will be steady and free from vibration or racking in any part of structure while traveling under maximum load. The design shall prevent any tendency for crane structure to get out of line while traveling along runway under any operating condition.
10. Cranes shall be designed to preclude leakage of lubricants onto the lifted loads or the floor. Equipment and components, which cannot be made leak-proof, shall be fitted with suitable drip pans. Drip pans shall be manufactured of stainless steel and designed to permit removal of collected lubricant.

E. Hoist and Trolley

1. The design shall be a single main hoist on one trolley.
2. Electric hoist shall be a two-speed drive. Hoist shall be equipped with spur-, helical-, or herringbone-gears, hardened and ground. Gearing shall have strength and durability ratings as per CMAA guidelines with AGMA Class quality class 9 or better. Gear train and bearings shall be oil-bath or splash lubricated.
3. Drive gears shall conform to AGMA 2001-B Quality Class 11 or better.
4. Unless otherwise specified, hoists shall be true vertical lift.
5. Gear reducers shall be integral components of standard hoists or hoist/trolley units of manufacturers regularly engaged in the design and manufacturing of hoists or hoist/trolley units for Class C cranes.
6. Hoisting gears shall be hardened and ground. Gears and pinions shall be spur, helical or herringbone type only, and shall be forged steel; open-type gearing is not acceptable. Gears and pinions shall be manufactured to CMAA or better precision. Gear reducer shall not incorporate a mechanical load brake; the gear reducer shall not require regular internal maintenance (such as mechanical load brake adjustment) and frequent lubricant changes due to friction material contamination and high running temperatures.
7. The hoist shall have a duty rating suitable for the load class and load cycles of the specified crane classification.
8. Load hook shall be of the Single Hook type. Provide only safety-type hooks.
9. When required between motors and gearboxes, couplings shall be flexible.
10. Fit trolley end trucks with bumpers to absorb the kinetic energy of the trolley coming into contact with the end stops at maximum speed without load.
11. Provide safety devices on each end truck to ensure that the trolley will remain on the rail and not drop by more than 1 inch in the case of a wheel shaft failure.
12. Trolley drive gearing shall be per CMAA requirements, hardened and precision ground, lubricated by semi-fluid grease.

13. All components shall be assembled at the factory into discreet units such as hoist, trolley, etc.
14. Provide OSHA-compliant guards on all machinery. For items requiring periodic visual inspection, make guards of mesh or other semi-transparent material. For guards that must be frequently removed, make guards hinged where possible with captive hold-down bolts.

F. Brakes

1. Hoist motor shall be furnished with electric disc brakes or mechanical conical rotor motor brake which holds load and is applied automatically on power removal. Hoist brakes shall be self-adjusting or adjustment free DC disc type with adequate torque to stop and hold over 125% of the hoist rated load.
2. Brakes shall be easily accessible for external adjustment by removing cover plates.

G. Motors

1. Hoist motors shall operate on 480 volt, 3-phase, 60 Hz, alternating current power supply, continuous duty and in accordance with Section 26 05 09.
2. All motor frame dimensions shall be in accordance with the NEMA MG 1 Standards. All bearings shall be the ball type and shall be adequate to withstand the maximum anticipated radial and axial loads. The bearing housings shall be provided with suitable seals to confine the lubricant and exclude moisture and dirt. Motor conduit connections shall be watertight.
3. Hoisting motors shall be two-speed/two winding squirrel cage type with a speed ratio of 6:1. Effective duty (ED) of hoisting motors shall be 60% ED (30 minute rated) or higher with minimum class “F” insulation. One thermal sensitive device embedded in hoist motor windings shall be provided. Thermal-sensitive device and associated circuits shall be self-restoring (automatic reset). Motors shall be designed specifically for crane and hoist duty.

H. Power Supply and Electrical Control System

1. Power supplied to the crane will be from a three-phase, three-wire, 480 volt, 3-phase, 60 Hz system. All power required for the crane operation of the hoist shall be developed from this source.
2. The hoist shall be CSA (US/Canada) approved and/or UL approved to NEMA 3R protection, or as otherwise specified. Hoist control enclosure shall be rated NEMA 4.
3. The Contractor shall install all wiring connecting the control panel with the drive motors and control devices in weatherproof conduits. All wiring and conduits on the bridge from and to the control panel, collector rings, motors, and limit switches shall be furnished.
4. Pendant festoon system shall consist of a support rail, cables, junction boxes, cable cars and accessories. Cable loops shall not drop below the hook high position. Pendant control car shall be provided with NEMA Type 4X junction box.
5. Hoist controls shall be full magnetic type, specifically selected for hoisting service.
6. All electrical equipment including motors, controls, resistors, brakes plus all conduit, wiring, panels and enclosures shall be in accordance with applicable requirements for materials, workmanship, construction and installation of the NEC.
7. gElectrical enclosures shall be NEMA 4. Each control panel and terminal cabinet shall bear the UL label. All panel doors shall have a mechanical pushbutton lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed or coded alike. The panels shall be completely fabricated with instruments installed and wired at the fabricator’s facility.
8. Pushbutton enclosure shall be NEMA 4X.
9. Electrical components, wiring, and panels shall be UL listed or recognized and in accordance with Section 26 05 00, Electrical Basic Requirements. Provide conductors in accordance with Section 26 05 19, Wire and Cable – 600V and Below.

I. Pushbutton Control

1. Crane and hoist shall be operable from ground level by a manually operated pendant pushbutton control station suspended from an independent traveling trolley mounted along the bridge.
2. Pendant pushbutton control shall be retractable, with a maximum retracted height of 3 feet off the finished floor.
3. Pendant control station enclosure shall be NEMA 4X Type. Physical size of pendant shall be held to a minimum. A separate cable of corrosion-resistant chain consisting of a minimum 6.4 mm (1/4”) wire shall be provided. Cable shall be integral with pendant control wire.
4. Push button control enclosure shall be NEMA 4X. Thermal overloads shall be provided for all motors. Hoist shall be equipped with overload cut-off device. Hoist and trolley control functions shall be combined with pushbutton control functions for crane motions.
5. The Contractor shall provide reduced voltage at pendant push button.
6. Operation push buttons shall be heavy-duty; type with distinctively felt operation positions which meet NEMA 4X requirements. Pendant control buttons shall be momentary push buttons. Push buttons shall be recessed type to avoid accidental operation. The size of the buttons shall be a size which will make operation possible with a thumb while holding the pendant with the same hand. Dual-position push buttons shall have a definite click-detent position for each speed. Push buttons shall be designed and manufactured not to hang up in control case. The pendant lever button controls station shall be programmed with the following functions:
   a. Hoist Up: two-speed pushbutton (Stop-Slow-Fast)
   b. Hoist-Down: two-speed pushbutton (Stop-Slow-Fast)
7. Pendant will have indicator light for power, hoist operating, and fault.
8. Pendant pushbutton station shall have a grounding conductor between a ground terminal in the station and the crane.
9. Control equipment shall be mounted in an enclosed compartment which forms an integral part of bridge crane and includes transformer for a 120 Volt control circuit.

2.4 DESIGN STRESSES

A. The maximum unit tensile or compressive stress in any material under the worst case condition, except where otherwise specified, shall not exceed 33 percent of the minimum yield strength nor 20 percent of the minimum ultimate strength required by the applicable specification for the material, whichever is less. Allowable shear and torsional stress shall be 50 percent of allowable tensile or compressive stress. Consideration for determination of worst case condition shall include all operating conditions.

B. All components shall be designed to prevent detrimental vibration or distortion during operation under all conditions specified.

2.5 FASTENERS

A. High-strength bolted connections shall utilize SAE Grade 5 bolts with corresponding lock washers, nuts, etc., conforming to requirements of AISC S329 or AISC RCSC. Galvanized bolts are not acceptable.

B. Fasteners for structural connections in not wetted areas shall be high-strength, heavy hex bolts in accordance with ASTM F3125, GrA325, Type 3 unless otherwise shown on the drawings. High-strength bolts shall be bearing-type connections with threads included in the shear plane, unless otherwise shown on the drawings.

C. Use body-fit bolts fitted in drilled and reamed holes

2.6 WELDING

A. Welders, welding operations and welding procedures shall be qualified or pre-qualified in accordance with AWS/ANSI D14.1 and Section 05 50 00 – Metal Fabrications. The surface of parts to be welded shall be free from rust, scale, paint, grease or other foreign matter. Minimum preheat and interpass temperatures shall conform to the requirements of AWS/ANSI D14.1.

Welding shall be performed in accordance with written procedures, which specify the Contractor's standard dimensional tolerances for deviation from camber and sweep. Such tolerances shall not exceed those specified in accordance with AWS/ANSI D14.1. Allowable stress ranges shall be in accordance with CMAA 70. Welding of girders and beams shall conform to AWS/ANSI D14.1.

B. Structural steel welding and NDT shall be in accordance with Section 05 50 00 – Metal Fabrications.

C. Where field welding of equipment is required, welding shall be in accordance with the manufacturer's recommendations. Where field welding to the building is required, it shall be done with the Engineer's approval in accordance with AWS/ANSI D1.1.

2.7 LUBRICATION

A. The Contractor shall make adequate provision for lubrication of bearing surfaces of all moving parts.

B. Before shipment, the Contractor shall properly lubricate all drives and other moving parts of the equipment to ensure protection against corrosion during shipment, storage and installation, and to ensure adequate lubrication for initial operation. Lubricants furnished shall conform to the manufacturer's printed recommendations and shall be supplied with Safety Data Sheet (SDS) where appropriate. Safeguards shall be provided where necessary to prevent operation of the equipment without proper lubrication.

C. All grease lubricated bearings shall be provided with grease nipples approved by the Owner. Each bearing shall be lubricated independently. All inaccessible feed points must be brought back to an easily accessible place using adequately supported tubing. Lubrication points for the bridge shall be routed to a common centrally located lubrication station and clearly labeled.

2.8 MISCELLANEOUS MATERIALS

A. Materials not included under detailed specifications herein shall be high-grade materials best suited to the purpose for which they are used and shall be subject to approval by the Owner.

2.9 MARKINGS, LABELS, WARNINGS AND IDENTIFICATION PLATES

A. Two capacity plates including the crane capacity in tons are required, one secured to each side of bridge crane. Each capacity plate shall be fabricated of steel or a quality/fade-resistant stick-on label with letters large enough to be easily read from the floor. Capacity plates shall be placed in a location visible to pendant operator's position after the crane has been installed.

B. Readable warning labels shall be affixed to each lift block or control pendant in a readable position in accordance with ASME B30.2. The word "warning" or other legend shall be designed to bring the label to the attention of the following information concerning safe-operating procedures: operating the hoist when the hook is not centered under the hoist; operating hoist with twisted, kinked or damaged rope; with a rope that is not properly seated in its hoist drum groove; lifting people; lifting loads over people; and removing or obscuring the warning label.

C. Manufacturer shall provide identification plates of non-corrosive metal with clearly legible permanent lettering giving the manufacturer's name, equipment model number, capacity in pounds, and other essential information or identification.

2.10 COATINGS

A. All components of the bridge crane shall be primed and finish coated in the manufacturer's shop. Paint system shall be per Section 09 96 00. The Contractor shall furnish at least four quarts of each color paint for future touch-up. Color shall be gray to match existing crane rail beam color.

B. The following items shall not be painted:

1. Rail surfaces in contact with wheels
2. Wheel running surfaces

3. Hoist chain
4. Conductor bar and festoon cables
5. Electrical bonding connection points
6. Stainless steel components

2.11 SOURCE QUALITY CONTROL

A. The Contractor shall submit a detailed shop test procedure for review by the Owner.

B. Manufacturer shall assemble the bridge, trolley and hoist, and functionally test it as a whole system at no load prior to shipment. All wiring shall be checked for continuity. The trolley shall be operated over its full travel and speed range. The hoist drive shall be operated at no load. All limit switches shall be functionally tested. Any deficiencies discovered shall be corrected by the Contractor prior to shipment. After testing and before dismantling for shipment, the Contractor shall assemble and test each control panel to demonstrate proper output signals and operation of electrical devices such as relays and timers. All above factory tests shall be witnessed by the Engineer.

C. Manufacturer shall submit test report for all test results.

D. Coatings shall be tested per Section 09 96 00.

E. The Contractor shall furnish all necessary labor, material and equipment, and shall perform all assembling and testing and make reports as required at no additional cost.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall align the existing rail to CMAA 74 requirements prior to installation of the new bridge crane. If the existing rail cannot be aligned to CMAA 74 standards, new rail shall be installed and aligned to meet the alignment requirements.

B. The Contractor shall provide the services of a manufacturer's engineering representative, specifically trained in the type of equipment to be furnished herein. The manufacturer's representative shall be present during alignment of the rail and installation of the crane bridge and hoist to check location of bracing and supports, setting and leveling, clearances, electrical connections and other critical components.

C. The Contractor shall confirm all dimensions and clearances in field prior to erection and be responsible for proper fitting and operation of equipment. The crane functions such as hoisting and lowering, trolley travel, bridge travel, limit switches and safety devices shall be tested to determine that the equipment will perform satisfactorily and safely without failure of any parts. Any defects in the equipment indicated by the tests shall be replaced/corrected and retested.

D. Bridge crane shall be installed in conformance with manufacturer’s instructions and inspected by a manufacturer’s representative. The Contractor shall provide all necessary accessories to make bridge crane complete, usable, and capable of meeting the operating requirements specified herein. The Contractor shall test, adjust, and clean equipment for acceptance by the Engineer.

3.2 FIELD TESTING

A. The Contractor shall submit a detailed test procedure for review by the Owner. The Engineer shall approve the procedures prior to any testing. Crane shall be tested in accordance with this procedure in the sequence provided.

B. Improper operation or poor condition of safety devices, electrical components, mechanical equipment and structural assemblies shall be monitored during the load test. Defects observed to be critical during the testing period shall be reported immediately to the Engineer and the testing operations shall be suspended until the defects are corrected. During each load test and immediately following each load test, the following inspections shall be made.

1. Inspect for bending, warping, permanent deformation, cracking or malfunction of structural components.
2. Check for overheating in brake operation; check for proper stopping. All safety devices including emergency stop switches and POWER-OFF pushbuttons shall be tested and inspected separately to verify proper operation of the brakes.
3. Safety accessories shall be inspected.
4. Check for abnormal noise or vibration and overheating in machinery drive components.
5. Check chain sheaves and run spooling for proper reeving and operation and freedom of movement, abnormal noise or vibration.
6. Check electrical drive components for proper operation, freedom from chatter, noise, overheating, and lockout/tagout devices for energy isolation.
7. Verify that locations of crane capacity plates are visible from pendant operator's position.

C. After final connections are made, specified equipment shall be tested for compliance with specifications in the presence of the Engineer using acceptance procedures provided by the manufacturer. The Contractor shall provide all personnel and testing equipment necessary to conduct required testing, including but not limited to crane operators, riggers, rigging gear and test weights. The Contractor shall operate all equipment and make all necessary corrections and adjustments prior to testing operations witnessed by the Engineer.

D. Hooks: Hooks shall be measured for hook throat spread before and after load test. Throat dimension base measurements shall be established by installing 2 tram points and measuring the distance between the tram points to within 0.4-mm (1/64inch). This base dimension shall be recorded. Distance between tram points shall be measured before and after load test. An increase in throat opening by more than 1 percent from base measurement shall be cause for rejection.

E. Dynamic Load Test: Test load shall be raised and lowered through the full range operating in each speed. Machinery shall be completely stopped at least once in each direction to ensure proper brake operation.

F. Hoist Loss of Power Test: After raising test load to approximately 8 feet, while slowly lowering the test load, the main power source and control push button shall be released to verify that the test load will not lower and that the brake will set.

G. Loss of power test: A test load of 100 to 105 percent of rated load shall be raised clear of any obstructions on the operating floor. Starting at a safe distance from walls or other obstructions, a slow speed shall be selected. While maintaining a safe distance from obstructions, the main power source shall be disconnected and brakes shall be verified to have set and that the equipment stops within the distance recommended by the manufacturer.

H. All crane equipment shall be operated through a complete lift and lowering cycle and through a complete travel of the bridge and trolley to determine that the equipment shall perform smoothly and safely and that pendant cable length is sufficient to permit operation from desired floor levels. The Contractor shall perform the test at least once. All tests shall be carried out with the bridge crane equipment loaded at 125 percent of capacity. Any defects shall be corrected by the bridge crane provider at no additional cost. The Owner's crane inspector shall be present during testing.

I. During the testing procedures, the Contractor shall make observations and records of all other specification requirements applicable to hoist operations. The Contractor shall record test data on appropriate test record forms suitable for retention for the life of the system. The Contractor shall record operating and startup measurements of currents for electrical equipment (motors and controls) using appropriate instrumentation (i.e., clamp-on ammeters). The Contractor shall compare recorded values with design specifications or manufacturer's recommended values; the Contractor shall justify abnormal differences (i.e., greater than 10 percent from manufacturer's or design values) or shall perform appropriate adjustments. In addition, the Contractor shall note, investigate and correct high temperatures or abnormal operation of any equipment or machinery.

J. All cranes and hoists shall be tested and certified by a Idaho licensed inspector.

K. An OSHA certificate shall be provided after successful completion of the load testing.

L. After the operational tests, bridge crane system and all functions of bridge crane shall be tested at 125 percent of rated load.

M. The Contractor shall be responsible for any deficiencies discovered and any repairs or modifications necessary for successful completion of the load test.

3.3 CLEANUP

A. Upon completion of work, area shall be cleaned and restored to its original condition, acceptable to the Engineer.

3.4 ERECTION AND STARTUP SERVICES

A. The Contractor shall provide services of erecting engineer in accordance with this specification.

B. The Contractor shall furnish the services of erecting engineers for this equipment. The erecting engineer shall check the installation in reference to alignments, clearances and adjustments, and all other matters pertaining to the quality of the installation. All notices or instructions shall be communicated to the Engineer. The erecting engineer shall be competent, reliable, responsible, and shall be preapproved by the Engineer.

C. The Contractor shall have at the site qualified startup engineer to confirm proper installation, electrical connections, limit switch and proper operation. The startup engineers shall be competent, reliable, responsible, and shall be preapproved by the Engineer.

D. Manufacturer's Representative:

1. A manufacturer's representative for the equipment specified herein shall be present at the Job Site and/or classroom designated by the Owner for the minimum person-days listed for the services hereunder for each of the separate facility locations, travel time excluded.
   a. 15 person-days for installation assistance and inspection per crane.
   b. 2 person-days for field functional and performance testing and completion of Manufacturer's Certificate of Proper Installation per crane.
   c. 1 person-days for pre-startup classroom or site training per crane. Training shall be videotaped by the Contractor and submitted to the Owner.
   d. 1 person-day for post-startup training of THE OWNER's personnel per crane: Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by the Engineer. Training shall be videotaped by the Contractor and submitted to THE OWNER.

3.5 SHOP ASSEMBLY

A. Major components shall be shop assembled as completely as possible.

B. All dimensions shall be verified in the shop.

C. All components shall be weighed and their actual (not calculated) weights recorded. Weights of all components shall be permanently recorded on the drawings and submitted tothe Owner for permanent record.

D. All components and subassemblies that will be shipped as a unit shall be clearly marked with lifting weight, center of gravity, and provided with factory installed and marked lifting lugs as required by this specification.

E. At the conclusion of the shop verifications and testing activities, carefully disassemble and match mark disassembled parts and tag electrical connections after complete no-load shop testing.

F. Arrange electrical harnesses with quick-disconnect plugs for rapid assembly in the field.

G. Prepare components for shipping.

3.6 SHOP TESTING

A. All crane functions must be shop tested and programming completed prior to shipping to site. This will include running all motors throughout their complete speed range and testing the functionality of all limit switches and safety devices to the extent possible in the shop.

B. Any controls related issues shall be resolved in the shop, not at the site, to minimize the time required for field erection.

C. Goal of the shop tests is to minimize the amount of time required to erect and test the crane at the site.

D. Before concluding the shop tests, make any necessary adjustments to the machine required to bring it into compliance with the specifications.

3.7 FACTORY ACCEPTANCE TEST (FAT)

A. After completion of all shop tests and programming activities, Contractor shall perform a final Factory Acceptance Test (FAT) prior to shipping for all factory-supplied equipment. The FAT will be witnessed by The Owner's representatives unless waived in writing by the Owner.

B. If parts are being supplied from multiple factory locations, Contractor shall provide a schedule of planned FAT's for the various shops and arrange the schedules so that the Owner has the option to witness all of them at its discretion, without conflicts.

C. Contractor shall prepare a FAT procedure and submit to the Owner for approval.

D. The FAT shall demonstrate all crane functions including operation throughout full speed ranges, brake operations, safety interlocks, etc. are operating per specifications.

E. FAT shall be scheduled near the conclusion of the manufacturing phase of the project.

3.8 WITNESS OF SHOP TESTING

A. Owner will witness the FAT at the Contractor's facility unless specifically waived by Owner in writing.

B. Owner reserves the right to witness any shop testing activities, particularly activities involving QC of major weldments, painting activities, etc.

C. Owner will not accept units until passed by Owner's inspector. Contractor shall submit the results of all shop tests and QC inspections for Owner approval.

3.9 SHIPPING

A. New equipment shall be fully shop tested before shipping to site. Shipping may not occur until released by Owner following review and approval of all factory test and inspection documentation.

B. Ship subassemblies as completely assembled as possible to minimize the time required for field erection.

C. All parts and equipment shall be protected from weather, damage, abuse, and loss of identification during shipping. Parts subject to damage from the elements shall be suitably protected with temporary lubricants, wrapping, etc.

D. Contractor shall be responsible for developing a shipping and transportation plan that accounts for road width, height, and weight restrictions and other factors from the point of origin until it arrives at the site including on-site access road limitations.

E. Contractor is responsible for securing all required over the road permits and other documents required for the shipment.

F. Contractor is responsible for all costs associated with packaging and shipping the equipment from its point of origin to the site.

G. Shipping and transportation plan shall be submitted to Owner for approval.

3.10 EQUIPMENT PROTECTION FOR SHIPMENT AND ON-SITE STORAGE PRIOR TO ERECTION

A. General consideration to the safe handling of the equipment shall be inspected on a regular basis to avoid any type of damage from manufacture site tothe Owner's site. This should limit and avoid damage during shipping due to inappropriate packing methods and lack of proper protection. If equipment is being stored on site, proper measures and protection shall be taken to avoid any further damage.

B. The Contractor shall prepare the materials and equipment for shipment in such a manner as to protect it from damage and weather while in transit and to facilitate off-loading, handling, and installation at the site. The Contractor shall ship equipment to site, unload it, place it in temporary storage if required, and deliver it to the installation location.

C. The equipment shall be shipped completely assembled as much as practical, wired, tested, painted, and crated for shipment.

D. Wood protectors shall be installed on all edges.

E. Loose hardware shall be securely boxed to prevent damage.

F. Electrical enclosures that are not weather-tight by design shall be protected against the elements before and during shipment.

G. Contractor shall ensure proper storage at the project site including any indoor storage, preventative maintenance, etc. Required prior to installation and commissioning. If any equipment requires special protection, temporary power, special storage precautions, etc. During on-site storage prior contractor's forces arriving on site for erection, contractor shall provide clear instructions to Owner regarding any and all temporary storage and protection requirements.

END OF SECTION

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DIVISION 43

PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT

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SECTION 43 05 23

COMMON WORK RESULTS FOR PROCESS LIQUID PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pumping equipment.

B. Related Specification Sections include but are not necessarily limited to:

1. Section 01 61 03 - Common Work Results for Equipment.
2. Section 03 15 19 - Anchorage to Concrete
3. Section 09 96 00 - High Performance Industrial Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ANSI/Hydraulic Institute (ANSI/HI):
   a. 9.6.3, Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region.

B. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

C. Pump/motor and VFD coordination: See Specification Section 01 61 03.

1.3 DEFINITIONS

A. The abbreviations used in this section are defined as follows:

1. AOR: Allowable Operating Range.
2. BEP: Best Efficiency Point.
3. IPS: Iron Pipe Size.
4. NPSH3: Net Positive Suction Head for 3% head loss.
5. POR: Preferred Operating Range.
6. TDH: Total Dynamic Head.
7. VFD: Variable Frequency Drive.

B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 61 03.
2. Product technical data including:
   a. Performance data and curves with flow (GPM), head (FT), horsepower, hydraulic efficiency, rotating speed (RPM), AOR, BEP, POR, NPSH3 requirements, minimum bowl submergence requirements for vertical mixed flow, axial and turbine pumps.
   b. Pump accessory data.
   c. Bearing supports, shafting details and lubrication provisions.
      1) Bearing life calculations.
      2) Critical speed calculations.
   d. Solids passage information.
   e. Anchor design information required by Section 03 15 19.
3. Certifications:

a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
b. Verification of Primary and Secondary conditions in POR and AOR.

4. Test reports:
a. Factory testing results.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Certifications:
a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Pumps:
a. See individual pump Specification Sections.

2.2 ACCESSORIES

A. See Specification Section 01 61 03.

B. Each Unit:

1. Lifting eye bolts or lugs.
2. Oil lubricated enclosed line shaft.

2.3 FABRICATION

A. Pump Support:

1. Design base to support weight of drive, shafting and pump.
2. Comply with HI vibration limitations.
3. Mount vertical turbine/propeller/can pumps on a rigid machined base plate attached to the discharge elbow. Base plate to be bolted to the pump can or an independent rigid machined sole plate grouted to the concrete substructure with anchor rods and leveled with jackscrews.
4. Fabricate to withstand all operating loads transmitted from the pump and drive.

2.4 SOURCE QUALITY CONTROL

A. Verification primary design condition in POR.

B. Verification secondary design condition in AOR.

C. If specifically required in the individual pump specification sections, provide factory tests:

1. All units:
a. Conduct tests in accordance with HI.
1) Shut-off head and design condition: Bilateral performance tolerance meeting Grade 2B per ANSI/HI 14.6 for Rotodynamic Pumps.

2. All pumps:
a. Head (FT) versus flow (GPM) pump curves:

1) Efficiencies along curve.
2) Brake horsepower along each curve.

3. Submit factory test results.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 01 61 03.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial start-up of equipment and perform operational checks.

B. If specifically required in the individual pump specification sections, provide field tests to:

1. Statically and dynamically balance each pump per ANSI/HI standards.
   a. To meet requirements of ANSI/HI 9.6.4 for Rotodynamic Pumps at any point on the pumps and motor.

END OF SECTION

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SECTION 43 24 05

PART 1 - VERTICALLY SUSPENDED CENTRIFUGAL PUMPSGENERAL

1.1 SUMMARY

A. Section Includes:

1. Vertically suspended centrifugal pumps, also termed "vertical turbine pumps", configured as required in this Section and as shown on the Drawings.

B. Related Sections include but are not necessarily limited to:

1. Section 01 61 03 - Equipment: Basic Requirements.
2. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.
3. Section 40 61 13 - Process Control Systems General Requirements.
4. Section 43 05 23 - Common Work Results for Process Liquid Pumps.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American National Standard Institute (ANSI):
   a. B16.1, Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Steel.
   b. A48, Standard Specification for Gray Iron Castings.
   c. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   d. A108, Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
   e. A120, Pipe, Steel, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless for Ordinary Uses.
   f. A242, Standard Specification for High-Strength Low-Alloy Structural Steel.
   g. A276, Standard Specification for Stainless Steel Bars and Shapes.
   h. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   i. A582, Standard Specification for Free-Machining Stainless Steel Bars
   j. A865 Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints.
   k. B505, Standard Specification for Copper-Base Alloy Continuous Castings.
   l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
3. American Water Works Association (AWWA):
   a. E101, Vertical Turbine Pumps - Line Shaft Type.
4. Hydraulic Institute Standards (HI):
   a. ANSI/HI 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values
   b. ANSI/HI 9.8, Rotodynamic Pumps for Pump Intake Design.
   c. ANSI/HI 14.6 Rotodynamic Pumps for Hydraulic Performance Acceptance Test.
5. International Organization for Standardization (ISO):
   a. ISO 1940-1, Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances.
   b.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
    a. See Specification Section 43 05 23.

B. Informational Submittals

1. Factory Test Reports
    a. Submit certified copies of factory test report pursuant to ANSI/HI 14.6.
        1) Receive Engineer's approval before shipping equipment.
    b. Report shall include:
        1) Test log(s).
        2) Description of test piping, equipment, and setup.
        3) Test procedure.
    c. Certified performance curves with a minimum of 5 points for an Acceptance Grade "1B".
        1) Head.
        2) Brake horsepower.
        3) Efficiency.
        4) Actual speed.
    d. Plot curve(s) to be easily read at scales consistent with performance requirements.
2. Field Test Reports.
    a. Vibration Tests -See Section 01 61 03.
    b. Submit field vibration test reports pursuant to ANSI/HI 9.6.4.

C. Contract Closeout Information:

1. Operation and Maintenance Data:
    a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 UNIT RESPONSIBILITY

A. The supplier of the pumps shall coordinate the pump design with the motors and VFDs to create a pumping unit assembly.

1. Assembly shall be tested and installed as a unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Simflo
2. Goulds/Xylem
3. Pentair Fairbanks Nijhuis
4. Floway
5. Ebarra
6. Byron Jackso / Flowserve
7. Layne-Bowler.
8. Or approved equivalent

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Parameters:

1. Pumps:
    a. High-Lift system, three identical 350 horsepower (hp) motors and pumps, each pump capable of 13 cubic feet per second (cfs) at Total Dynamic Head (TDH) = 186 feet with

less than a NPSHR = 30.9 feet, a 24-inch diameter suction bell with a height from the floor equal to 12 inches.

b. Low-Lift system, three identical 350 horsepower (hp) motors and pumps, each pump capable of 26 cubic feet per second (cfs) at Total Dynamic Head (TDH) = 94 feet with less than a NPSHR = 30.9 feet, a 34-inch diameter suction bell height with a height from the floor equal to 17 inches.

c. High-Lift pumps discharge to 18-inch steel piping with ANSI flanges with underground discharge heads.

d. Low-lift pumps discharge to 20-inch steel pipes with ANSI flanges with underground discharge heads.

e. All six motors shall be identical solid shaft, 350 hp, 460 VAC, 3-phase, 60 hz, premium efficiency, inverter duty production motor with steady bushing and anti-reversing ratchets.

B. Provide pumps with increasing head characteristics from secondary design conditions to primary design condition.

C. Provide pumps with net positive suction head requirements (NPSHR) less than the net positive suction head available (NPSHA) at all operating conditions. NPSHA is 34.0 feet.

2.3 COMPONENTS

A. General:

1. Furnish units consisting of an oil lubricated lineshaft vertical turbine, direct connected to a vertical solid shaft motor. Furnish unit with non-reversing ratchets.
2. The pump shall be designed and furnished to conform to the Hydraulic Institute and AWWA specifications for Lineshaft Turbine Pumps.
3. Weight of revolving parts of pump including unbalanced hydraulic thrust of impeller is carried by thrust bearing in driver.
4. Make provision at driver shaft for adjusting impeller with reference to bowls.
5. Provide registered fit between discharge head and motor.
6. Provide opening and guard for access to coupling.
7. Provide threaded inserts for lifting lugs.
8. All welds ground smooth.
9. Coating pursuant to 09 96 00 for high performance industrial coating systems.
   a. Consider environment corrosive for surface preparation.
   b. Stripe coat all exposed sharp edges and exposed edges fabricated/machined parts, flanges and threads after assembly between prime coat and finish coat with intermediate/finish coat system.
10. All stainless-steel welded parts passivated, ASTM A380.
11. Design pumps to operate without damage from reverse rotation due to return of water through column.
12. Support pump from base plate sized to support entire operating pump assembly. Machine base and sole plate for registered fit.
13. Mount driver on support stand or column extension from base plate with access provided to shaft seal.
14. Dynamically balance propeller in accordance ISO 1940 grade 6.3 standard.

B. Sole Plate

1. Use existing sole plates to mount the base plate (motor stand) to.
2. Verify base plate spans the pump opening in the sole plate and aligns with existing mounting holes.

C. Column:

1. Construct discharge column pipe of ASTM A53 Grade B carbon steel with flanged connections.
2. Provide intermediate column sections not exceeding 5 feet in length.
3. Abrasive blast column and coat column OD/ID with a minimum 12 mils dry film thickness epoxy system at the factory.

D. Enclosed Line Shaft:

1. Construct line shafting from 1045 carbon steel, turned, ground and polished.
2. Construct the shaft coupling of steel, ASTM A108, Grade 1213 or 1215.
3. Provide shaft sections having maximum length of 5 feet.
4. Enclose line shaft in tube constructed of ASTM A53 SCH 80 carbon steel pipe, in sections also not to exceed 5 feet in length.
5. Provide bronze line shaft bearings at maximum 5 feet intervals.
   a. Furnish tension nut stretch assembly to provide tension on shaft enclosing tube and to serve as line shaft bearing. Construct bearing portion of assembly from bronze and assure it is designed not to "freeze" to shaft enclosing tube.

E. Line Shaft Lubrication

1. Manufacturers:
   a. Pneumatic Pumps:
      1) Graco/Husky (part number 241906)
      2) ARO
      3) Or approved equivalent
   b. Oil Controller
      1) Dripmaster EDD-4C
      2) Or approved equivalent
2. Components
   a. Pneumatic Diaphragm Pump
   b. Suction tube, 1-inch diameter, black steel or stainless steel
   c. Double tapped bushing
   d. Camlock, ¾-inch
   e. Various fittings and flexible hoses
   f. 3-way solenoid valve
   g. 35-gallon (minimum) oil reservoir with sight glass
   h. Oil reservoir level sensor
   i. Wall mount anchoring and shelf for pneumatic pump
   j. Wall mount anchoring for oil reservoir
   k. Aluminum or copper or black steel mainline and branch piping and fittings.
   l. Nuts and Bolts
   m. Fittings and flexible hose
3. Equipment
   a. Pneumatic Pump
      1) Air inlet: ¼” female NPT
      2) Fluid inlet size: ¾ in female NPT
      3) Fluid outlet size: ¾ in female NPT
      4) Body housing: Aluminum
      5) Maximum flow: 12 to 16 gpm
      6) Maximum air pressure: 100 psi

7) Compatible material: oil, mineral oil

4. Provide 3-way solenoid valve to open when oil level in 35-gallon reservoir reaches a programmed set point; solenoid valve to close when oil level reaches the high-level set point and purge to the air pump atmosphere.
5. Supply maximum air pressure of 100 psi and up to 28 scfm of clean, dry air to pneumatic pump via the 3-way solenoid valve.
6. Provide and field fit a suction tube to fit a 55-gallon drum to draw oil from the bottom of the drum. Use a double tap bushing threaded to the drum's 2-inch opening.
7. Provide and field fit camlock connectors and ball valve to allow the air pump's suction line to disconnect from the drum with no drainage.
8. Provide an oil level sensor in the wall-mounted reservoir with low-low level, low level, high level and high-high level capabilities.
9. Provide 1" mainline pipe (coper or aluminum or black steel) from the 35-gallon reservoir with ½" drop pipes and isolation valve to each of the six (6) oil controllers.
   a. Provide automatic solenoid operated oil controller to each of the six (6) pumps.
10. Oil reservoir to have an external sight glass.
11. Oil controller shall have a peep glass and SCADA compatible monitoring for lack of oil, sufficient oil, and pre-lube mode.
12. Install oil controller per manufacture's recommendations.

F. Pump Bowl and Suction Bell:

1. Provide bowl and suction bell constructed of ASTM A48, Class 30 close grained cast iron, free from imperfections and accurately machined and fitted.
2. Coat pump bowl water passages with an abrasion-resistant baked enamel, phenolic or epoxy.
3. Coat OD of bowls with a minimum of 12 mils dry film thickness epoxy system at factory.
4. Design to ensure easy removal of bearings and impeller.
5. Furnish suction bell with flared end to reduce entrance losses and with a sufficient number of vanes to support lower guide bearings and weight of impeller and pump shaft when dismantling pump.

G. Bearings:

1. Provide units with sleeve bearings of ASTM B505bronze in each bowl and in suction bell.
2. Ensure bell bearing is permanently packed type with packing to be a non-soluble grease.
3. Provide ASTM 505 or B584bronze bearing and sand collar for bell bearing to prevent abrasives from entering bearing.
4. Ensure top bowl bearing extends into discharge column adapter.

H. Bowl Shaft and Impeller:

1. Provide bowl shaft constructed of rolled and ground 416 or 410 stainless steel.
2. Furnish enclosed type impellers constructed of bronze (ASTM B534 (903)) and securely attached to impeller shaft.
3. Ensure impeller is accurately fitted and statically and dynamically balanced.

I. Discharge Head Assemblies:

1. Provide discharge head assembly for 150 psi working pressure and 250 psi test pressure.
2. Provide underground discharge head constructed of fabricated steel (ASTM A36)] with ASME B16.1, 125/150 LB flange.
3. Weld flange to column pipe at specified elevation.
4. Construct base plate of steel (ASTM A36).
5. Mount base plate to existing sole plate; attach discharge head to base plate.
6. Ensure base plate is of sufficient size to span opening in support structure.

7. Supply base plate with lifting lugs capable of supporting weight of entire unit.
8. Abrasive blast discharge head OD/ID and coat with a minimum 12 mils dry film thickness epoxy system at the factory.

J. Fasteners for Bowls and Columns

1. Provide nuts, bolts and washers of 316 SST
2. Entire pump assembly shall have a final surface preparation after assembly.
3. Stripe-coat all fasteners and connection points of flanges and parts.
4. Final coat entire assembly in the shop.

K. Tension Nut Stretch Assembly:

1. tension tube, ASTM A53 grade B carbon steel (sch 80).]
2. Provide tension nut, ASTM B584 bronze.
3. Provide assembly to promote positive lubrication to line shaft bearings.

L. Data Plates:

1. Provide stainless steel data plate securely attached to pump.
2. Include manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.

M. Motors:

1. 350 horsepower, solid shaft, premium efficiency, inverter duty production motor with steady bushing.Reduce voltage] starting, vertical hollow shaft, squirrel cage, induction type.
2. 460 V, 60 HZ, 3 PH.
3. WP-I type with 1.15 service factor.
4. Size motor to drive pump continuously over the complete head - capacity range without the load exceeding the nameplate rating.
5. Design Motors for 4,450 ft elevation above sea level.
6. Comply with Section 01 61 03.

2.4 Source Quality Control

A. See Section 43 05 23.

B. Factory Performance Test:

1. Submit certified copies of factory test report pursuant to ANSI/HI 14.6.
   a. Receive Engineer’s approval before shipping equipment.

2.5 MAINTENANCE MATERIALS

A. Extra Materials:

1. Furnish the Owner the following extra parts for each pump service category:
   a. Suction bowl bearing: One set.
   b. Intermediate bowl bearing: One set.
   c. Discharge bowl bearing: One set.
   d. Line shaft bearing assemblies: One set.
   e. Tension assembly bushing and O-ring: One set.
   f. Lip seal: Two.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. See Section 43 05 23.

END OF SECTION

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DIVISION 46

WATER AND WASTEWATER EQUIPMENT

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SECTION 46 21 12
INLINE CANAL TRAVELING SCREENS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Inline Canal Traveling Screens.

B. Related Sections include but are not necessarily limited to:

1. Section 01 35 73 – Delegated Design Procedures.
2. Section 01 61 03 – Common Work Results for Equipment.

C. Coordination:

1. Discharge to concrete landing per contract drawings.
2. Coordinate delivery, installation, and startup of screen system.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. American Iron and Steel Institute (AISI):
   a. Steel Products Manual.
2. NEMA
   a. Enclosures
3. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.

B. Qualifications:

1. Supplied by a single manufacturer or supplier.
2. Manufacturer shall have installed a minimum of ten similar size and configuration units over each of the last ten years.

1.3 SUBMITTALS

A. Shop Drawings:

1. See requirements in Section 01 61 03.
2. Scaled plan and sections showing dimensions, weights, structural supports, embedments, clearances, and screen discharge interface.
3. Minimum screenings lifting capacity.
4. Minimum gear reducer output torque.
5. Installation list.
6. Field lift test report.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
   a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 SITE CONDITIONS

A. Location:

1. Agricultural: Existing Irrigation canal traveling screen at main canal siphon.
2. Open, exterior location.

B. Exposures:

1. Rainfall.
2. Wind (including dust and dirt).
3. Direct sunlight.
4. Submergence in surface water.

C. Area Weather Conditions:

1. Operating temperature range: 30 F to 105 F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Traveling screens:
   a. International Water Screens.
   b. Approved equivalent.

2.2 EQUIPMENT

A. Performance and Configuration Requirements:

1. Traveling Screen:
   a. Flow:
      1) Maximum flow rate: 150 cfs.
   b. Dimensions:
      1) Width: 7’-10”
      2) Length: 42’-6”
      3) Screen shall be installed within the existing and expanded concrete traveling screen support structure as shown on the drawings.
   c. Frame Material and Dimensions:
      1) Mild steel coated with two-part epoxy.
      2) Dimensions: 12-inch channel iron with 6-inch square tubing and 2.5-inch angle iron cross-member supports.
   d. Wear Surfaces: 2.5-inch angle iron coated with ultra-high molecular weight polyethylene.
   e. Underwater Bearings: Non-lubricated sleeve and bushing bearing.
   f. Screening Media and Spacing:
      1) 12-guage 304 Stainless Steel Wire.
      2) Vertical Openings: 12 openings per foot
      3) Horizontal Openings: 10 openings per foot
   g. Screen Media Support:
      1) Materials: 304 Stainless Steel
      2) Chain: C2060
   h. Discharge height: As shown on the project drawings.
   i. Screen incline: As shown on the project drawings.
   j. Control Panel: Enclosed within NEMA 4 enclosure

2.3 ACCESSORIES

A. Controls:

1. End of travel (park position) limit switch.

2. Reverse motion (reverse permissive) limit switch.
3. High torque (rake jam) switch.
4. High motor temperature switches.
5. Manufacturer provided local control station equipment to provide the following functions:
   a. Control and indicators.
      1) Local switch – Manual Operation Only
      2) Reverse jog pushbutton.
      3) Forward jog pushbutton.
      4) Run light.
      5) High temperature light.
      6) High torque (jam) light (amber).
      7) High channel level light (amber).
      8) Alarm horn.
      9) Alarm silence pushbutton.
      10) Screen forward runlight (red).
      11) Screen reverse runlight (red).

2.4 MAINTENANCE MATERIALS

A. Extra Materials.
   1. Furnish Owner spare parts as recommended by the manufacturer.
   2. Furnish the Owner the following extra parts:
      a. One torque switch and limit switch of each type on screen.
      b. Three wiper blades.
      c. Set of cog wheels.
      d. Roller and bushings for 20 feet of pin rack.

PART 3 - EXECUTION

3.1 PREPARATION

A. Field verify channel dimensions prior to fabrication.

3.2 INSTALLATION

A. See Section 01 61 03
   Vertically and horizontally align, level and plumb units into position.

3.3 FIELD QUALITY CONTROL

A. Employ and pay for services of the equipment manufacturer's field service representative to:
   1. Inspect equipment covered by this Specification.
   2. Supervise pre-startup adjustments and installation checks.
   3. Conduct initial start-up of equipment and perform operational checks.
   4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   5. Instruct Owner's personnel per Section 01 75 00 for 8 hours at jobsite on operation and maintenance of the equipment.

B. Field Test:
   1. Following installation, Contractor will conduct a performance test to verify the lifting capacity of the bar screen.
      a. Operate machine at manufacturer’s recommended speed and load.

b. Lift load from the bottom of the channel to a point at the top of the screen.
c. Reverse screen, returning the loaded screen to the channel floor.
d. Repeat for 20 cycles, during which time the structural support members will be checked for deflection or evidence of wear or undue stress to the screen components.

2. If screen fails test:
   a. Modify unit until passes test.
   b. Replace unit with heavier duty model.

END OF SECTION