JORDAN VALLEY WATER CONSERVANCY DISTRICT

JORDAN VALLEY WATER CONSERVANCY DISTRICT
WEST JORDAN, UTAH

JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES

CLIENT PROJECT NO. 202001

CONTRACT/TECHNICAL SPECIFICATIONS

100% SUBMITTAL

VOLUME 2 OF 6

DIVISIONS 01 - 09

FEBRUARY 2025

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JORDAN VALLEY WATER CONSERVANCY DISTRICT

JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES

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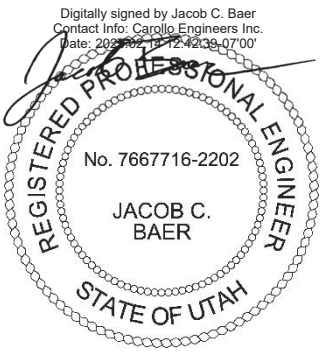

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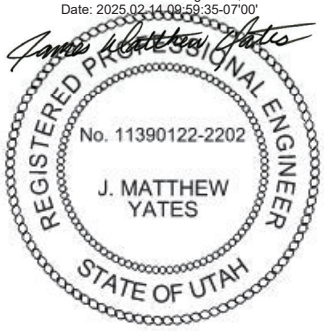

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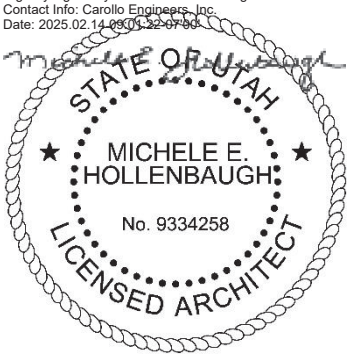

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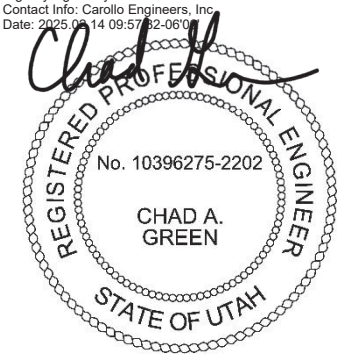

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JORDAN VALLEY WATER CONSERVANCY DISTRICT

JORDAN VALLEY WATER TREATMENT PLANT FILTER AND CHEMICAL UPGRADES

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APPENDICES

SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Detailed description of the Work.

1.02 THE WORK

A. The Work consists of expanding the existing filters and chemical facilities to accommodate a future net production capacity of 255 million gallons per day (mgd) at the Jordan Valley WTP and includes the following major elements:
   1. Raw water channel: Installation of new chemical pipe connections
   2. Flash mix facilities: New chemical piping connecting to existing diffusers.
   3. Chemical facilities:
      a. Modifications to pipe routing and installation of new piping for chemicals.
      b. Primary coagulant: Existing bulk tanks will be modified, new transfer pumps installed, and a new Day Tank and metering equipment install.
      c. Chlorine gas: A new Chlorine Building will be constructed, with new piping connected to existing piping. Existing storage and metering will be demolished.
      d. Cationic polymer (PEC): New bulk storage, day tank, and metering will be installed in the existing Filter Building. An existing bulk storage in the Primary Coagulant Building currently utilized for PEC will be repurposed for Primary Coagulant.
      e. Anionic polymer (PEA): New PEA batching, storage, and metering systems will be installed in the existing Filter Building. New dosing locations will be installed in the Flocculation Basins. Existing PEA system, on the third floor of the Administration Building, will be connected to this new system as a standby system.
      f. Powdered activated carbon: New storage silos and feed equipment will be installed outside to create a new PAC Area, connecting to existing piping. Existing PAC equipment will be demolished.
      g. Fluoride: Carrier water for this existing system will be adjusted to utilize a connection on new plant water piping.
      h. Chlorine Dioxide: Existing chlorine dioxide generators will be modified by manufacturer to increase their capacity. Existing feed tubing for this system will be replaced.
   4. Plant water: New connection to existing piping and installation of new piping.
   5. Flocculation and Sedimentation Basins: New PEA (floc aid) dosing locations are being adding to existing basins.
   6. Filter Inlet Channels (Sedimentation Basin Effluent Channels): Demolition of existing filter inlet weirs.
   7. Filters:
      a. Demolish and install new filter media, troughs, underdrains, and nozzles.

b. Demolish and install new magnetic flow meters, flow control valves, and effluent piping.
c. Demolish and install new filter-to-waste piping, valves, and air gap structure.
d. Replace existing filter inlet and waste washwater valves.

8. Finished water piping/reservoir: New chemical dosing points will be added in the Clearwell Outlet Structure.
9. Backwash improvements:
   a. Construct new 1-million gallon (MG) pre-stressed concrete backwash tank.
   b. Construct new backwash tank vault, valves, and associated piping.
   c. Replace flowmeter, existing flow control valve, and add new isolation valves.
   d. Replace the air scour blower motors.
10. Miscellaneous:
    a. Installation of new emergency power generator.
    b. Civil yard and grading improvements.
    c. Utility modifications to support the overall work.
    d. Repair and reconstruction of existing improvements affected by the Work, and incidentals for complete and usable facility.
    e. Installation of a canopy over the entrance walkway.
11. Commissioning of the Work.

1.03 LOCATION OF PROJECT

A. The Work is located at the Jordan Valley Water Treatment Plant, 15305 S 3200 W, Herriman, Utah 84065.

1.04 OWNER ASSIGNED SUBCONTRACTORS

A. Employ Owner-assigned Subcontractor for PLC and SCADA programming, as follows:
   1. Contractor shall contract with and employ Steve Anderson, APCO, Inc. at (801) 519-9500 as the PLC and SCADA Programmer for this project.
   2. Responsibilities and tasks of the Programmer as outlined in Division 17 of these Contract Documents shall be completed by APCO. Cost of work shall be included in Contractors bid and payment for executing these tasks shall be made by the Contractor.
   3. Contractor shall have primary responsibility for coordinating the Work with Programmer. This coordination includes, but is not limited to, the overall project schedule, submittals, programming-related meetings, factory acceptance testing, field testing, trouble shooting, training, commissioning and startup.

1.05 ACTIVITIES BY OTHERS

A. Owner, utilities, and others may perform activities within Project area while the Work is in progress.
   1. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

1.06 PARTIAL USE OR OCCUPANCY

A. Substantial Completion on the following portions of Work for Owner's occupancy is required prior to overall project completion. See General and Supplemental General Conditions for additional details and dates:
   1. New Chlorine Building.
   2. New Caustic Soda Building.
   3. New PAC Silos.

B. Certificates of Substantial Completion will be executed for each designated portion of Work prior to Owner occupancy.
   1. Such certificate of Substantial Completion will describe the portion of the Work to be occupied by Owner, items that may be incomplete or defective, date of occupancy by Owner, and other information required by Owner and Contractor.

C. Following occupancy, Owner will:
   1. Provide power to operate equipment and systems.
   2. Repair damage caused by Owner's occupancy.

D. Following occupancy, Contractor will:
   1. Allow access for Owner’s personnel, access for others authorized by Owner, and Owner operation of equipment and systems.
   2. Enter into agreement with Owner indicating work that remains to be performed in occupied areas.
   3. Correct defects if Owner’s use of occupied facilities reveal defective work,

E. Due to the length of time of overall project and the need to maintain operations, the following portions of work are anticipated to require partial utilization prior to substantial completion:
   1. Individual filters
   2. New Filter-to-Waste (FTW) piping and manhole
   3. Modifications to the filter backwash system

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01116

CONTRACT DOCUMENT LANGUAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Explanation of arrangement, language, reference standards, and format.

1.02 REFERENCES

A. Construction Specifications Institute (CSI):
   1. MasterFormat™.
   2. SectionFormat™.
   3. PageFormat™.

1.03 PROJECT MANUAL ARRANGEMENT

A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

1.04 CONTRACT DOCUMENT LANGUAGE

A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section.
   1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.

B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all."
   1. Assume missing portions by inference.

C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
   1. When used as an appositive after designation of product, colons are used in place of words "shall be."

F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, or render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.

G. Words "Contractor shall" are implied when direction is stated in imperative mood.

H. Term "products" includes materials and equipment as specified in Section 01600 - Product Requirements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

1.02 SUBMITTALS

A. Baseline Schedule with MOP tasks.

B. Method of Procedure (MOP) Form.

C. Method of Procedure (MOP) Log.

D. Progress Schedule with MOP tasks.

1.03 METHOD OF PROCEDURE (MOP)

A. Comply with MOP Instructions as specified in Attachment A - Method of Procedure (MOP).

B. Prepare MOP for the following conditions:
   1. Shutdowns, diversions, and tie-ins to the existing facility.
   2. Process start-up activities.
   3. Power interruption and tie-ins.
   4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.
   5. Process constraints requiring interruption of operating processes or utilities.

C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.

D. Submit Baseline Schedule, as specified in Section 01321 - Schedules and Reports with proposed MOPs.

E. Submit MOP Log at construction progress meetings.

F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.

G. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.04 GENERAL CONSTRAINTS ON WORK AND SCHEDULING OF WORK

A. Plant access for Contractor will be provided at the south gate (from Mountain View Corridor).

B. Perform abandoned pipe Work as specified in Section 01738 - Selective Alterations and Demolition.

C. Water projects:
   1. The Jordan Valley Water Treatment Plant is the Owner's primary source of drinking water during the majority of the year. Except for the winter months, Owner is unable to meet its potable water demands without this facility.
   2. Conduct Work such that the Owner's ability to meet its customer's demands for treated drinking water shall not be impaired or reduced in terms of the required quantity or quality of treated water. Do not impair the operational capabilities of essential elements of the treatment process or reduce treatment capacity below levels sufficient to meet demands for water throughout the contract time. The quantities of and quality of treated water required are described in this Section.
   3. Conduct commissioning activities as specified in Section 01756 - Commissioning in a manner that will not impair capabilities of essential elements of the treatment process or reduce treatment capacity below levels sufficient to meet demands for water throughout the contract time. The quantities of and quality of treated water required are described in this Section.
   4. The status of the treatment plant shall be defined as "operational" when the plant is capable of meeting the Owner's customer's demands for treated drinking water in terms of the required quantity or quality of treated water as defined in this Section.
   5. All shutdown durations are inclusive of drain and refill time and will be measured from the time the plant is no longer producing water until the time the plant resumes producing water.

D. The constraints provided in this Section are contractual obligations that limit the Contractor's activities and the Contractor's impact to plant operations.

E. Contractor shall comply with local restrictions and requirements, including the Salt Lake County noise ordinance.

F. Hazardous material removal (such as lead based paint removal) cannot occur while the WTP is operational. For additional requirements and restrictions, see Section 01354 - Hazardous Material Procedures.

1.05 COMPLIANCE WITH DRINKING WATER PERMIT

A. The existing facility is operating to meet all drinking water regulation, as required by federal agencies and the State of Utah.

B. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.

C. Bear the cost of penalties imposed on the Owner for water quality violations caused by actions of the Contractor.

D. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment.
   1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

1.06 UTILITIES

A. Provide advance notice to and utilize services of Blue Stakes for location and marking of underground utilities operated by utility agencies other than the Owner.

B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

C. New yard utilities were designed using existing facility drawings.
   1. Field verification of utilities locations was not performed during design.
   2. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
   3. Pipe alignments as indicated on the Drawings.

1.07 WORK BY OTHERS

A. Where proper execution of the Work depends upon work by others, inspect and promptly report discrepancies and defects.

B. No other significant work on site by others is anticipated for the duration of the project. Minor work for ongoing maintenance and operation of the facility is required to maintain its operations; these activities will be coordinated with Contractor's work as they are identified.

1.08 REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

A. Facilities or conditions required to keep the existing plant operational include, but are not limited to, the following:
   1. Electrical power including transformers, distribution wiring, and motor control centers are required during plant operations. Emergency backup generator power for all facilities.
   2. Raw (untreated) water. The existing 90-inch raw water pipeline, raw water meter vault, and raw water channel.

3. The flash mix facilities.
4. Chemical storage, metering, conveyance, and control facilities for treatment process chemicals.
    a. Primary coagulant: Coagulant is stored in the existing Primary Coagulant Building and conveyed to chemical metering equipment in the basement of the existing Administration Building.
    b. Chlorine: storage and metering is provided by existing storage for ton cylinders and existing chlorinators.
    c. Cationic polymer (PEC): PEC is stored in one of the bulk storage tanks in the existing Primary Coagulant Building and conveyed to chemical metering equipment in the basement of the existing Administration Building.
    d. Anionic polymer (PEA): PEA is stored and metered on the third floor of the Administration Building to the filter inlet channels.
    e. Powdered activated carbon located in the chlorine loading dock and basement of the Administration building
    f. Fluoride: Fluoride is stored in the existing Fluoride Building and dosed utilizing chemical metering equipment. Carrier water is used to dilute the solution during delivery.
    g. Chlorine dioxide: Chlorine dioxide is generated onsite using chlorine gas.
5. Plant water, to supply potable water to the plant, including fire sprinklers and fire hydrants. Plant water is supplied by gravity from the culinary tank through the existing 12-inch PW pipe.
6. The flocculation and sedimentation basins and sludge handling facilities.
7. Filter Inlet Channels (sedimentation basin effluent channel).
8. Filters.
9. Filter effluent piping from each filter.
10. Finished water piping/reservoir. The Clearwell Outlet Structure and 90-inch FW is required for plant operations to convey filtered water the finished water reservoirs.
11. Backwash system: Existing BW tank, piping, waste washwater handling facilities, and air scour blowers and piping.
12. Plant air. The plant air system.
13. Laboratory facilities. The laboratory facilities.
14. Office, toilets, and washrooms.
15. Fencing and gates. See Section 01500 - Temporary Facilities and Controls for temporary fencing requirements.
16. Lighting.
17. Heating, ventilation, and air conditioning.
18. Instrumentation, meters, controls, and telemetry equipment.
19. Safety equipment and features.
20. Parking for District employees and vehicles required for operation and maintenance. Existing parking spaces or suitable replacement parking, coordinated with the District must be maintained.
21. Telephone system.
22. Storm drainage.
23. Natural gas service. Natural gas service is required during winter months to heat the buildings.
24. Contractor shall coordinate all construction activities that limit access to the existing loading dock with the Owner. Access to the loading dock at the

existing chemical building is not required during extended plant shutdowns but must be allowed at the beginning and end of a scheduled shutdown.

B. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational except during scheduled plant shutdowns.

1.09 SHUTDOWN CONSTRAINTS

A. General shutdown constraints:
   1. Execute the Work while the existing facility is in operation, with limited shutdowns as allowed below.
   2. Some activities may be accomplished without a shutdown.
   3. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
   4. Organize work to be completed in a minimum number of shutdowns.
   5. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
   6. Shutdown MOPs:
      a. Advise the Engineer a minimum of 3 weeks prior to need for any shutdown.
      b. Prepare and submit MOP to Engineer for any shutdown required a minimum of 2 weeks prior to the shutdown.
      c. Owner's written approval of MOP is required prior to beginning Work.
   7. Where required to minimize treatment process interruptions while complying with specified constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
   8. Final determination of the permitting of shutdowns will be the sole judgment of the Owner.
   9. Owner maintains the ability to abort on the day of the scheduled shutdown.
   10. Unplanned shutdowns due to emergencies are not specified in this Section.
   11. Contractor shall anticipate that existing process valves and gates leak, including those on the filters. If basins, channels, or filters are isolated by existing valves or gates but undrained, management of water will be required, even when plant is shutdown.
   12. Drains for basins and tanks, as well as drains within the plant go to lagoons. Large volumes of water shall be drained slowly to avoid overwhelming the drainage and lagoon system - approximately 1 million gallons in an 8-hour period unless otherwise coordinated with and approved by the Owner.

B. Plant shutdowns that may be requested include the following:
   1. Complete Plant: This shutdown ceases water production from the WTP.
   2. Partial Plant: This is a shutdown of one side of the main plant processes, including flocculation, sedimentation, and filtration. This type of shutdown can be conducted following modifications to the backwash system, described below in this Section. Facilities that serve both sides of the plant (e.g. chemical facilities) need to remain in service during a partial plant shutdown.
   3. Unit Process: This is a shutdown of one of multiple units within a particular process. (e.g. one filter, one floc/sed basin).
   4. Support Facilities: These are facilities that support plant operation, but with coordination, can be taken offline for a short period of time without restricting plant production.

C. Specific Shutdown Constraints for each type of shutdown are listed in the table below. Depending on production requirements and operating conditions when the work is being performed, some adjustments may be accepted by Owner. However, Contractor shall utilize the constraints listed below for planning purposes and not rely on acceptance of adjustment to the constraints to perform the Work.

Type of Shutdown	Allowed[1]	Additional Requirements	Types of Activities that may be Performed
Complete Plant	Nov 1 - Feb 28 Only: One 120-day shutdown each winter. Oct - 1 - Oct 31 Only: One 2-day (48 hours) shutdown. Mar 1 - Mar 31 Only: One 2-day (48 hours) shutdown.	None.	- Chemical feed tie-ins for new chlorine, caustic, and PAC. - Chemical feed tie-ins for primary coagulant, PEC. - Chlorine dioxide tubing replacement to raw water meter vault. - Cutting new filter effluent piping into Filters 1-6 and into FE channels for Filters 7-16. - FTW tie-in MH connection. - BW yard piping modifications. - New BW supply north and south control valves, BWS valve, flowmeter.
Partial Plant	Oct 15 - Apr 15 Only: Up to 3 months in duration.	One week is needed to switch to half plant operations or change which half the plant is in operation. No shutdowns allowed May 15 - Sep 15.	- Work on either north or south filters. - PEA filter feed points. - Replace chlorine dioxide tubing to filter inlet channel. - Demo filter inlet weirs. - Replace filter inlet and waste washwater valves. - Replace filter effluent piping upstream of effluent and FTW valves. - Replace individual filter BW vales (after new BW supply N and S control valves are installed).
Unit Process	Up to 1 month in duration.	Shutdowns must be separated by 1 week. No shutdowns allowed May 15 - Sep 15.	- Minor modifications/adjustments within a filter box. - Installing PEA piping in a flocculation basin.
Support Facilities	Up to 4 hours in duration, unless mutually agreed that a longer duration is tolerable.	Shutdowns must be separated by 1 week. No shutdowns allowed May 15 - Sep 15.	- Backwash system modifications. - Cleaning/emptying of existing PEC storage tank to convert to use with primary coagulant.

Notes:
1. No shutdowns allowed during the WTP's maximum production period, May 15 through September 15.

1.10 WORK SEQUENCE

A. The following work sequences, arising from the need to maintain plant operations, have been identified by the Owner and Engineer and are presented for the benefit of the Contractor. The work sequences presented herein are not meant to be complete nor exhaustive but are intended to provide an example upon which Contractor may develop overall project schedule.

B. General Work Sequence: The following general sequence for completing major elements of the Work is intended to provide an example of a sequence for completing the work within work restrictions. The work can generally be broken into 2 sequences, Chemicals and Filters, that have a few interconnecting items.

C. Chemicals:
   1. Provide submittals for long lead items - these are anticipated to include the PAC System and electrical equipment. Conduct the Technical Service Survey visit for the Chlorine Dioxide Generator. Conduct the petrographic analysis in the PEC Area.
   2. Earthwork and site preparation, including utility relocation, for the new Chlorine Building, Caustic Building, and PAC. Installation of components for temporary configuration for signals and power to the Culinary Tank and relocated gate. (Occurs in coordination with backwash tank site preparation - see Filters.)
   3. Repowering the Culinary Pump Station to create capacity in the existing electrical distribution system for the new chemical facilities connected at SWBD-CS.
   4. Construction of the new Chlorine Building, Caustic Soda Building, and PAC system. As Backwash Tank Valve Vault receives power from electrical infrastructure in the Caustic Soda Building, this infrastructure must be operational prior to connection of the new backwash tank - See Filters. Similarly, the existing Culinary Tank (offsite) is ultimately repowered through the Caustic Soda Building; once electrical infrastructure in this building is complete final power routing for the existing Culinary Tank can be completed.
   5. During the full plant shutdown:
      a. Complete chlorine dioxide generator modifications and replace chlorine dioxide tubing.
   6. During a winter full plant outage:
      a. Modify chemical piping and connections in existing facilities including Filter Building Basement, Floc/Sed Basins, Flash Mix, Clearwell Outlet Structure and Raw Water Meter Vault.
      b. Complete minor modifications in the Fluoride Building.
   7. Startup and commissioning of Chlorine Building, Caustic Building, and PAC system.
   8. Substantial completion Chlorine Building, Caustic Building and PAC System.
   9. Complete the new PEA and PEC systems:
      a. Perform petrographic analysis at PEC Area.
      b. Demolish the existing chlorine gas system and PAC components in the Filter Building.
      c. Complete structural modifications.
      d. Install new PEA and PEC systems.

10. Complete electrical work, including permanent generator installation and utilization of existing switchboard salvaged from the alternative power supply work (see filters section).
11. Startup and commissioning new PEA and PEC systems.
12. Owner takes partial utilization of systems.
13. Demolish existing PC and PEC day tanks and feed systems in the basement of the Filter Building.
14. During a winter full plant outage:
    a. Complete modifications in the Primary Coagulant Building.

D. Filters:
1. Provide submittals for long lead items - these are anticipated to include electrical equipment for the alternate power supply and VFDs for the backwash pumps, new or re-wound backwash pump.
2. Submit and procure backwash supply valves, flowmeter, filter media, and underdrains.
3. Earthwork and site preparation, including utility relocation, for the new backwash tank and yard piping connections. Activities occur in coordination with new Chemical Building site preparation - see Chemicals.
4. Conduct potholing and exploratory excavation needed for confirmation of existing utility location. Submit FTW MH connection components. Procure and install FTW MH and piping up to point of connection to existing waste washwater.
5. Submit materials and procedures for FTW tunneling work.
6. Submit new backwash tank and connecting yard piping and procure materials. Construct tank and yard piping to the Backwash Tank Valve Vault.
7. During a winter full plant outage:
    a. Install the backwash supply valves and flowmeter.
    b. Connect the FTW MH to the existing waste washwater.
    c. Construct the Backwash Tank Valve Vault and connect the new backwash tank. (Electrical work at the Caustic Soda Building to be sufficiently complete to power these components - see Chemicals.)
    d. Although not requiring a outage, complete the FTW tunneling work during the winter outage period.
8. Owner takes partial utilization of systems installed during the full plant outage, after startup testing.
9. Using field measurements for FTW tunneling work, develop and submit filter gallery piping fabrication drawings.
10. During a winter full plant outage:
    a. Install electrical equipment for the alternate power supply and relocate existing switchboard for use in the Culinary Pump Station. (See chemical section above).
    b. Replace the filter blower motor.
    c. Install backwash pump.
    d. Install the VFDs for the backwash pumps.
11. Owner takes partial utilization of systems installed during the full plant outage.
12. During a partial plant outage:
    a. Complete in-filter box work for Filters 1, 3, 5.
13. During a full plant outage:
    a. Complete filter gallery work on the north (odd) filters and connect to the new FTW piping. Demo filter inlet weirs on the north filters.

b. Begin demolition of in-filter box components of Filters 7-15 (odd only).

14. During a partial plant outage:
    a. Complete in-filter box work for Filter 7-15 (odd only).
15. Owner takes partial utilization of north filters.
16. During a partial plant outage:
    a. Complete in-filter box work for Filters 2, 4, 6.
17. During a full plant outage:
    a. Complete filter gallery work on the south (even) filters and connect to the new FTW piping. Demo filter inlet weirs on the south filters.
    b. Begin demolition of in-filter box components of Filters 8-16 (even only).
18. During a partial plant outage:
    a. Complete in-filter box work for Filter 8-16 (even only).
19. Owner takes partial utilization of south filters.
20. Startup and commissioning of any remaining systems.
21. Final Completion.

1.11 CONSTRUCTION SEQUENCING CONSTRAINTS

A. Activities described below relate to construction sequencing and scheduling constraints for each of the major work elements. This information defines the requirements but is not intended to substitute for the Contractor's construction schedule nor dictate means and methods for performing the Work.

B. Mobilization: Preparatory work activities to be completed up-front and part of Contractor mobilization include, but not limited to:
    1. Installation of temporary construction fencing and/or new final fencing to secure the property. Relocation of south WTP access gate on 3200 West is required as part of this project. Power and signals for controlling gate opening and closing, and intercom/camera shall be relocated when the gate is relocated to maintain full functionality of the gate for plant operations. The operations manual and other information about this south WTP access gate is provided as an attachment to the Supplemental General Conditions.
    2. Temporary utilities including water, electrical power, sanitary sewer, communications, etc. as defined in Section 01500 - Temporary Facilities and Controls.
    3. Coordination and submittal of long lead items.
        a. Concrete mix design including shrinkage testing per Section 03300 - Cast-in-Place Concrete.
        b. Contractor shall provide submittals for the following items within 3 months of notice to proceed, unless otherwise approved in writing by the Engineer:
            1) PAC System.
            2) Emergency Generator.
        c. Contractor shall coordinate submittals of all remaining items to achieve delivery dates required by their schedule. This may include, but is not limited to transformers, switchboards, and other electrical and mechanical components.

C. Verification of existing underground facilities:
    1. Prior to submitting any shop drawings for piping, Contractor shall pothole or conduct other exploratory investigations to verify the locations of the existing

piping at connections and points of potential interference. Contractor shall confirm depth and alignment of all critical utilities a minimum of 60 days prior to work on utilities. Contractor shall notify engineer in writing of any discrepancies between information indicated on drawings and locations/depths determined by field investigations.

D. Verification of existing underground electrical facilities:
   1. Prior to submitting any shop drawings for buried conduits or duct banks, Contractor shall pothole or conduct other exploratory investigations to verify the locations of the existing connection points and points of potential interference. Contractor shall confirm depth and alignment of all critical utilities a minimum of 60 days prior to work on utilities. Contractor shall notify engineer in writing of any discrepancies between information indicated on drawings and locations/depths determined by field investigations.

E. Relocation of existing underground facilities:
   1. Several existing utilities require relocation prior to construction of new facilities. These include:
      a. Cell Tower Power: Power for transformer for the cell phone tower (XFMR CELL) at the south end of the site must be installed prior to the removal of the existing connections for construction of the Chlorine Building, Caustic Soda Building, and Backwash Tank.
         1) Cell Tower is owned and maintained by Verizon Wireless LLC, through an agreement with the District. Power outages to XFMR CELL must be limited to 8 hours in duration. District will coordinate with Verizon; Contractor shall notify the District a minimum of three weeks in advance of an outage to facilitate this coordination.
      b. Power and Signals to Culinary Tank (located offsite) and relocated gate power and signals:
         1) Culinary Tank (located offsite) must be powered and have communication at all times. Communication and power to the Culinary Tank must be relocated before construction of the Backwash Tank. In addition, the relocated gate must have power and communication at all times. In final configuration, both the Culinary Tank and the relocated gate power and signals utilize infrastructure in the Caustic Soda Building.
         2) As shown in electrical drawings, for temporary power and signals prior to availability of infrastructure in the Caustic Soda Building:
            a) Contractor shall install:
               (1) Permanent panelboard.
               (2) Permanent electronics enclosure,
            b) Contractor may install:
               (1) Temporary step-up transformer, to be provided by Owner, to be powered from permanent panelboard (PNL-CELL) to provide temporary power.
               (2) If utilized, Contractor will be responsible for installation and removal, returning the transformer to the Owner when no longer needed.
            c) Contractor may utilize a temporary fiber connection to PB #2 from the electronics enclosure. Existing conduits in PB #2 can

then be used by the Contractor for a temporary fiber connection into existing facilities for temporary communication.

F. Connection to existing utilities:
   1. Natural Gas. This work includes a new connection and meter to existing natural gas piping.
      a. Contractor shall complete the connection between June 1 and August 31 when warmer temperatures do not required heating the buildings.
      b. Contractor shall work with natural gas service provider (Enbridge Gas [previously Dominion Energy]) to coordinate timing of the installation of the new gas meter and other gas utility provided services for the new backup generator.
   2. Potable Water: New connection to the existing potable water loop is required. Potable water loop must remain operational at all times as it serves life-safety systems in the existing facilities.

G. Excavation and subgrade preparation: Before constructing slab-on-grade concrete, Contractor shall excavate or backfill and compact subgrade to proper elevation.
   1. Excavation: The existing contours on the civil drawings show approximate elevations of the existing site. The Contractor shall conduct any additional field surveys and investigations to meet construction requirements. Soil compaction and subgrade requirements are defined in the drawings and specifications.
   2. Piping Below Slabs. Process and facility structures have basin drains, floor drains, sub-drains, and process piping constructed and encased below slab-on-grade. This subgrade piping work shall be coordinated and constructed prior to slab construction.
   3. Obtain approval from Engineer and its geotechnical engineer once excavation for each structure is complete and prior to installing any backfill.

H. Power for new facilities and upsized motors: Existing facilities cannot support additional loads of the new facilities and upsized motors. To accommodate the new facilities, alternate power for some existing infrastructure must be installed.
   1. Modifications at Sectionalizer 1 to adjust power service for Culinary Pump Station must be completed prior to powering new buildings from SWBD-CS. Work at Sectionalizer 1 will disconnect the Culinary Pump Station from utilizing the existing backup power (emergency generator) for the site; a new backup power generator will be installed at the Culinary Pump Station as part of this project. Backup power capabilities must be available at the Culinary Pump Station at all times:
      a. Backup power will be provided by the permanent generator following installation.
      b. At the Contractor’s request, and following coordination of hookup requirements, the District can meet this need by providing a portable generator, which the District would bring to site during a power outage if the new generator is not installed at the time of Sectionalizer 1 work. Contractor must have completed work necessary to allow connection of this portable generator and coordinated with the District to conduct testing to demonstrate functionality with their portable generator.
   2. A new transformer (XFMR-APF) and switchboard (new SWBD-APF) will be installed near the FWW Clarifier. These must be installed prior to powering new MCC-BL, which is needed for replacement of the air scour blower motors.

These must also be installed to facilitate removal of (existing) SWBD-APF, which will then be relocated to the Culinary Pump Station, and renamed as SWBD-CPS.

I. Chemical feed: New connections to existing chemical feed infrastructure and new connection points will be required for chemicals.
   1. Existing chemical dosing must be maintained at all times plant is in operation. Dosing connections at the Raw Water Meter Vault, Raw Water Channel and Clearwell Outlet Structure are anticipated to require full plant shutdowns.
   2. Prior to Contractor working on chemical piping and connections:
      a. District staff will flush chemical lines to remove bulk chemical to the extent feasible.
      b. Contractor remains responsible for implementing safety measures and providing appropriate protection from chemicals for their staff working around chemicals and shall anticipate residual chemical may be encountered following flushing.
   3. Chemical piping shall be cleaned, destination tested, and pressure tested prior to placing back in service, as required by Section 15052 - Common Work Results for General Piping.

J. Chemical deliveries: Chemical deliveries are required at active chemical storage facilities. Contractor must coordinate work to accommodate required chemical deliveries.
   1. Primary coagulant is delivered from bulk trucks to the Primary Coagulant Building. Delivery frequency is monthly from October through April, and weekly at all other times.
   2. Chlorine is delivered in ton containers using the loading dock adjacent to the existing chlorine storage room. Delivery frequency is twice monthly during October through April, and weekly at all other times.
   3. Powdered activated carbon is delivered from bulk trucks to the loading dock adjacent to the chlorine storage room. Delivery frequency is twice monthly during October through April and more irregularly during other periods.
   4. Fluoride is delivered from bulk trucks to the Fluoride Storage Building. Delivery frequency is monthly from October through April, and weekly at all other times.
   5. PEC is delivered in palletized 50 pound bags via the elevator. Delivery frequency is approximately monthly.

K. Chlorine Building: The new Chlorine Building replaces the existing chlorine facility in the existing building and preserves its application points.
   1. The performance test period, described in Section 01756 - Commissioning, shall be 14 days for the Chlorine Building. Owner may elect to utilize existing systems during a portion of this time to empty partially full containers; use of existing systems for this purpose will not extend the performance test length.
   2. All safety systems, including chlorine scrubber, must be fully operational prior to placing any chlorine gas containers in the building.
   3. Substantial completion for the Chlorine Building must be achieved for the District to begin operations utilizing this facility. Once substantial completion has been achieved, any remaining work in the Chlorine Building shall be in accordance with the Owner’s risk management plan.

4. Relocation of the existing scrubber serving the existing chlorine storage room, to act as a backup system to this facility, is not required for substantial completion of the Chlorine Building.
5. Owner will be responsible for delivery, handling, or moving of chlorine gas cylinders. Contractor shall coordinate timeframes with Owner.

L. PAC Silos: The new PAC silos replace the existing PAC slurry storage and feed in the existing building and preserves its application points.
1. Substantial completion for the PAC silos must be achieved for the Owner to begin operations utilizing this facility.
2. The new PAC Silos must be fully constructed and commissioned before any demolition of the existing PAC equipment or related activities that impact the use of existing PAC systems are conducted.
3. Compliance with NFPA 652 must be confirmed before PAC Storage and Handling submittal approval (See Section 13270 - PAC Storage and Handling System). Contractor shall allow a minimum of 8 weeks after delivery of complete PAC system submittal for Owner to conduct Dust Hazard Analysis and related activities, as outlined in Section 13270 - PAC Storage and Handling System.

M. Existing Chlorine Storage Room and PAC Slurry Storage Demolition: Components in the existing Chlorine Storage Room and in the PAC Slurry tanks will be demolished and new PEA/PEC systems will be installed in this space.
1. Work in the chlorine storage room shall be in accordance with the Owner's risk management plan.
2. The new Chlorine Building and PAC System must be substantially complete prior to any demolition of the existing chlorine and PAC equipment is conducted.
3. Once the Chlorine Building is substantially complete, Owner will be responsible for removing all stored chlorine gas from this area. Contractor shall coordinate timeframe for this activity with Owner. Safety systems, including scrubber, shall remain in place and active until all gas is removed from the chlorine storage room. Contractor shall remain vigilant during demolition, providing appropriate equipment and mitigation measures for any chlorine solution or gas that may be encountered in equipment and piping.
4. After gas is removed, contractor shall relocate the existing scrubber to act as a backup system for the Chlorine Building, as noted on drawings.
5. Once PAC Silos are substantially complete, Owner will empty existing carbon slurry tanks to the extent feasible. Contractor shall anticipate approximately 6" of remaining slurry in the carbon tank that requires removal and disposal. Due to the nature of carbon slurry, the tank environment may be oxygen deficient.

N. PEA, PEC, and PC equipment: The new PEA, PEC, and PC feed equipment replaces existing equipment located elsewhere in the existing building and replaces existing PEC storage currently in the Primary Coagulant Building. It preserves the feed points, adds new PEA feed points to flocculation, and retrofits the existing chemical feed points to the filters.
1. Contractor shall submit petrographic analysis of concrete at the PEC Area within 3 months of NTP. See 69S05
2. Work, other than the petrographic analysis, in the PC/PEC and PEA metering rooms (refer to Drawing 69M01) cannot begin until demolish activities,

including removal of chlorine gas, is completed - see Existing Chlorine Gas Storage Room and PAC Slurry Storage Demolition.

3. Placement of new concrete pads and curbs and installation of mechanical components in the area cannot begin until structural reinforcement of the existing slab has taken place, in accordance with structural drawings.
4. All new pumps and chemical feed equipment shall be fully and successfully tested, both functional and operational, with water and then appropriately flushed prior to being exposed to chemical.
5. The new PEA, PEC, and PC Equipment will be performance tested for 14 days prior to Owner accepting equipment for utilization.
    a. Contractor shall performance test the PC system with only the two new PC feed pumps that are being provided. Once performance testing of the new system is complete, the existing PC feed pumps can then be moved over to their new location. The relocated pumps shall be tested following installation at the new location.
    b. The PEC system can be performance tested with one of the two existing PEC feed pumps. During this time, the existing PEC system will remain as a backup, but will not have a standby pump. Once the new system is commissioned, the other existing PEC feed pump shall be moved to its new location. The relocated pump shall be tested following installation at the new location..
6. The existing PEC and PC equipment in the basement cannot be demolished or modified until Owner accepts new equipment for utilization
7. The existing PEA storage and feed equipment on the upper floors will remain in place as backup to the new PEA storage and feed.

O. Primary Coagulant Building: As part of this Work, piping connecting the existing Bulk Tanks will be modified and new transfer pumps installed
    1. One of the bulk tanks in this building provides storage for PEC. Following owner utilization of the new PEC Storage Tanks, Contractor shall adjust the piping on this tank to allow it to become a PC Storage Tank.
    2. Owner will drain and rinse existing PEC Storage Tank. Contractor shall anticipate that some amount of water with dilute chemical will remain in the bottom of the tank; Contractor shall be prepared to pump out of the bottom of the tank into a tote or drum for Owner disposal prior to adjusting the piping connections to this tank.

P. Caustic Soda Building: The new Caustic Soda building provides a new chemical feed system to the filtered water for pH adjustment.
    1. The water softener shall be installed, connected, and operational prior to receiving the first load of caustic soda.
    2. Prior to introducing caustic soda to the system, it shall be flushed completely with softened water.
    3. All safety systems must be operational prior to receiving any caustic soda in this facility.
    4. Substantial completion for the Caustic Soda Building must be achieved for the District to begin operations utilizing this facility.

Q. Chlorine Dioxide: The Work includes modifying the existing chlorine dioxide generators to achieve higher capacity units and replacing the aging braidflex tubing to the points of application.
   1. Contractor shall coordinate with supplier to conduct Technical Service Survey visit, described in the manufacturer scope of work (see Section 11263 - On-Site Chlorine Dioxide Generation System) - a minimum of two months ahead of Contractor's planned time for generator work to allow for manufacturer to incorporate site findings into the generator work.
   2. Chlorine Dioxide generator work and replacement of the tubing must be completed by the end of the first winter of construction.
   3. Both the duty and backup generator must be available when the plant is operational.

R. Fluoride Building: The work includes modifying the carrier water connection into the fluoride building.
   1. Carrier water is required to maintain fluoride operations.

S. BW Supply and New Tank Construction: Modifications to the BW system include work inside the Filter Building and work outside the building. The BW system must be available when the plant is in operation.
   1. Work inside the Filter Building includes addition of new filter BW supply valves on the BW header to allow the filters to be separated into north and south halves of the WTP, the addition of new BW flowmeter, and the replacement of the existing BW Control Valve.
      a. These modifications must be done during a full plant outage.
      b. BW Supply piping from the BW Supply tank must be drained for these modifications.
      c. The new filter BW supply valves on the BW header must be installed prior to any half-plant shutdowns.
   2. Work inside the Filter Building also includes the addition of VFDs to existing BW Supply Pumps (used to fill the BW Supply Tank), re-winding of one BW Supply Pump for inverter duty operation, and modifications to the existing blowers to upsize the motors. See additional electrical requirements under "Power for New Facilities and upsized motors".
      a. Motors on the blowers must be upsized prior to conducting backwashing of new filter media with filter troughs at a higher elevation.
      b. Re-winding (or replacement) of one BW Supply Pump must be done before operating on a VFD.
      c. VFDs on the BW Supply pumps must be installed and operational prior to conducting backwashing of new filter media.
   3. Work outside of the building includes construction of a new BW Supply Tank and construction of the Backwash Tank Valve Vault to connect the new tank and existing facilities.
      a. The BW Supply Tank is redundant to the existing tank. Tank can be constructed independent of facility operations. Utility relocation is needed prior to tank construction - see "Relocation of existing underground facilities".

T. Filter to Waste (FTW) MH: This work includes installing an air gap MH and connection to the existing waste washwater piping for new FTW piping that is installed in the filter gallery.
    1. As noted on drawings, the existing waste washwater pipe location and elevation must be field verified prior to preparation of shop drawings for this work.
    2. Existing waste washwater pipe must be operational whenever the facility is operating.
    3. Although facility may not be operational, Contractor shall be prepared to manage limited, steady flows of water in the waste washwater channel and piping. Drains from filters, basins, and tanks are directed to this waste washwater system. Owner will support work by isolating identifiable sources of drainage to the extent feasible. Existing gates and valves from filters, to be replaced as part of this project, will leak to this channel and piping if filters are not drained.
    4. The new FTW piping, MH, and connection must be operational prior to bringing upgraded filters online.

U. Filter to Waste Piping beneath existing cross gallery: This work requires filter to waste piping between Filters 5 and 7 and Filters 6 and 8 be placed beneath the existing structure. Tunneling beneath the existing gallery foundation is required for this work.
    1. Tunneling work must be conducted during the time period when a full plant outage is allowed, even if contractor means and methods do not require a plant outage.
    2. Tunneling must be conducted prior to preparation of pipe layout drawings for filter gallery piping in this area, as field verification of acceptable pipe placement is required. See drawings.

V. Filters: The Work includes removing filter inlet weirs, replacing filter valves, modifying filter effluent piping with connections, flow meters, and FTW piping, replacing underdrains and media and replacing the troughs at a higher elevation. This work increases the filtration rate and modifies the filter control strategy from level-control filters to rate of flow control filters.
    1. The Finished Water Reservoir (FWR) inlet valve must be open when any filter is in operation to maintain connection with the overflow protection weir located inside the FWR
    2. Everything downstream of the filter media is considered potable facilities, including the filter media, underdrain, collection flume, filter effluent piping, backwash supply tank and piping, and FTW piping to the FTW MH. Consequently, disinfection and appropriate protection of disinfected facilities is required where the work affects any of these areas.
    3. During work on each filter, the adjacent filters shall be protected from construction dust, debris, and overspray at both the deck and gallery levels.
    4. The surface of the filter media shall be protected from any and all foreign matter during the entire construction period.
    5. All filter valves for a filter being modified shall be closed and lockout/tagout procedures followed if the filters on that side of the plant are operating.
    6. The following filter modifications require a full-plant shutdown:
        a. Making the new filter effluent connections to the existing clearwell (Filters 1-6) and to the existing filter effluent conduit (Filters 7- 16).

7. Contractor must field verify all dimensions prior to submitting shop drawings for valves and piping.
8. Contractor must have filter media, valves, and piping on site for the filters prior to beginning demolition of an existing filter.
    a. All sand and anthracite for all filters must be produced at the same time and shipped to the site. Separate media production lots are not allowed.
    b. Contractor must properly store all filter media.
9. Underdrain and media placement require backwash testing (see Section 13224 - Filter Underdrain System and Section 13226 - Filter Media). Waste backwash water is directed to a recovery system. Water treatment facility must be operating to accommodate recycling of this water; the ability to process recycled water is limited. Contractor shall plan for a maximum production of 3.5 million gallons of waste washwater to be generated by construction activities each day. Additional capacity may be available, as determined by Owner, based on plant production demands at the time of work, but Contractor shall assume no more than this value for scheduling/planning purposes.

10. It is anticipated that Contractor will complete work on the filters over multiple years due to the time limitation of the full plant shutdowns.
    a. It is acceptable to operate with some unmodified filters using existing control strategies and some fully modified filters with new filter control strategies provided that Contractor provides different SCADA screens and backwash setpoints for each condition.
    b. It is not acceptable to put a partially modified filter into service. Once construction has started on a particular filter, it must be completed prior to placing back into service.
11. Filter gallery piping for a filter must be completed and programming available to operate the filter in a rate-of-flow control mode prior to demolishing the filter inlet weir.
12. Existing waste washwater gates/valves will be replaced as part of this work. See “FTW MH” for management of water in the waste washwater channel and piping.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - METHOD OF PROCEDURE (MOP)

"METHOD OF PROCEDURE" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	No later than 7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	No later than 7 days prior to work
Contractor	6. Complete Readiness Checklist.	No later than 5 days prior to work
Contractor	7. Complete Safety Checklist.	Immediately prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submits 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in Contract Documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the Work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete Work.

Contractor completes Work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

ATTACHMENT B - METHOD OF PROCEDURE (MOP) FORM

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ **Date:** _____

Contractor: _____ **Carollo Project No.:** _____

Project Name: _____ **Submittal No.:** _____

Submittal Title: _____ **Spec/Drawing. Ref.:** _____

MOP #:	TASK TITLE: *(Provide <10 word title)*	SUBMITTAL DATE: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY:

START: *(Date/Time)* END: *(Date/Time)*

REQUESTOR:

PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:

NOTIFY: ☐	Control Room, Phone:	☐	Security, Phone:

BUILDING:	LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e. control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT / TOOLS: *(Pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:							
☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect. Emergency	☐	Natural Gas	☐	Storm Drain	☐	
REVIEWER'S INSTRUCTIONS/COMMENTS:							
☐	PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:						

	Full Name (printed)	**Signature**	**Phone**	**Date**
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

ATTACHMENT C - READINESS CHECKLIST

READINESS CHECKLIST

(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____

2. Review work plan: _____

3. Review contingency plan: _____

ATTACHMENT D - SAFETY CHECKLIST

SAFETY CHECKLIST

(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

ATTACHMENT E - METHOD OF PROCEDURE (MOP) LOG

METHOD OF PROCEDURE (MOP) LOG
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (Yes/No)
001					
002					
003					

SECTION 01210

ALLOWANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Listing of allowance items:
      a. Related responsibilities of Contractor and procedures.

1.02 ALLOWANCE AMOUNTS

A. Include the following amounts in Contract Price. These items shall be included under Bid Item Number 5, on the bid form:
   1. $40,000 for miscellaneous concrete repair as specified in Section 03926 - Structural Concrete Repair, as identified by the Owner.
   2. $20,000 for Owner requested materials testing.
   3. $80,000 for furnishing web based construction document management software as specified in Section 01322 - Web Based Construction Document Management, for Owner and Engineer use. This allowance excludes Contractor's use of the software, which shall be included in the contract price.
   4. $20,000 for structural improvements, as directed by Owner, based on the results of the required petrographic analysis.
   5. $30,000 for Owner directed repairs to existing chemical diffusers. Drawings reflect connection to existing diffusers at the WTP, but condition of diffusers is unknown.
      a. This allowance is for removal and repair or replacement of the diffusers should the Owner determine they are deficient during construction activities.

B. Include the following amounts in the Contract Price, these items shall be entered by the contractor on separate lines in the bid form.
   1. Bid Item Number 6: Items listed in the Powdered Activated Carbon Dust Hazard Mitigation Allowance Schedule, with value as provided by Bidder in the bid form.
   2. Bid Item Number 7: Items listed in the Chlorine Dioxide Generator Optional Equipment Allowance Schedule, with values as provided by Bidder in the bid form.

1.03 COSTS INCLUDED AND EXCLUDED IN ALLOWANCES

A. Costs included in allowances for furnishing products only:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes and fees.

B. Costs included in Contract Price, but not included in allowances for furnishing products only:
   1. Handling at site, including uncrating and storage.
   2. Protection from elements, theft, and damage.
   3. Labor, installation, testing, and finishing.
   4. Other expenses required to complete installation.
   5. Overhead and profit.

C. Costs included in allowances for furnishing and installing products:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes.
   4. Handling at site, including uncrating and storage.
   5. Protection from elements and from damage.
   6. Labor, installation, testing, and finishing.
   7. Other expenses required to complete installation.

1.04 DUTIES OF CONTRACTOR IN PROVIDING PRODUCTS BY ALLOWANCE

A. Advise ENGINEER at least 60 days in advance of purchase date necessary to avoid impacts to Progress Schedule.

B. Obtain proposals from suppliers, including:
   1. Quantity.
   2. Complete description of product and services provided under allowance.
   3. Unit cost.
   4. Total amount of purchase.
   5. Taxes and delivery charges.

C. On notification of selection, enter into purchase agreement with designated supplier.

D. Arrange for delivery and unloading.

E. Install products in accordance with Contract Documents.

1.05 ADJUSTMENT OF COSTS

A. When actual cost is more or less than amount of allowance, Contract Price will be adjusted by Change Order.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01260

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for executing a change in the Work.

1.02 PRELIMINARY REQUIREMENTS

A. Change Order Cost Basis Summary Form:
   1. Submit a sample to Engineer for review within 15 calendar days following Notice to Proceed.
      a. Items will be reviewed and their value, percentage, or calculation method mutually agreed to by the Contractor and Owner prior to executing a Change Order on the Project.
   2. Used by the Contractor for pricing each Change Order required for additions, deletions, or revisions in the Work.
   3. Include the following information:
      a. Agreed upon markups, percentages, and procedures for calculating all surcharges, etc. associated with the Cost of the Change Order Work.
      b. References for unit price information and special unit price information.
      c. Attachments with the following information:
         1) Certified labor rates breakdown.
         2) Equipment rates.
         3) Bond and insurance rates (PI&I).

1.03 REQUEST FOR INFORMATION OR INTERPRETATION (RFI)

A. Contractor may issue RFIs to request interpretation of the documents or to request for information that may be missing.

B. General Instructions:
   1. Number RFIs consecutively.
      a. Add a consecutive letter to the RFI number on modified submittals of the same RFI (i.e., RFI 4B).
   2. Provide RFI for 1 item.
      a. There may be exceptions when multiple items are so functionally related that expediency indicates review of the group of items as a whole.
      b. RFIs with multiple items will be rejected without review.
   3. Contractor sign and date RFIs indicating review and approval.
      a. Contractor’s signature indicates that they have satisfied RFI review responsibilities and constitutes Contractor's written approval of RFI.

b. RFIs without Contractor's signature will be returned to the Contractor unreviewed. Subsequent submittal of this information will be counted as the first resubmittal.

C. Engineer will render a written clarification, interpretation, or decision on the issue submitted or initiate an amendment or supplement to the Contract within 21 days.
   1. In the event the Contractor identifies an RFI as critical to the progress of the project, Engineer will make every effort to reduce the RFI response time.

1.04 PRELIMINARY PROCEDURES

A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor including the following information:
   1. Detailed description of the Change, Products, and location of the change in the Project.
   2. Supplementary or revised drawings or specifications.
   3. Projected time span for making the change, and a specific statement if overtime work is authorized.
   4. A specific period of time during which the requested price will be considered valid.
   5. Such request is for information only, and is not an instruction to execute the changes, or to stop work in progress.

B. Contractor may initiate changes by submitting a Change Proposal to Engineer containing the following:
   1. Description of proposed changes.
   2. Reason for making changes.
   3. Specific period of time during which requested price will be considered valid.
   4. Effect on Total Contract Cost and/or Contract Time.
   5. Documentation supporting any change in Total Contract Cost and/or Contract Time, as appropriate.

1.05 WORK CHANGE DIRECTIVE AUTHORIZATION

A. In lieu of a Request for Proposal (RFP), Engineer may issue a Work Change Directive Authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. Authorization will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change and will designate method of determining any change in the Contract Sum and/or the Contract Time, as appropriate.

C. Owner and Engineer will sign and date the Work Change Directive Authorization as authorization for the Contractor to proceed with the changes.

D. Contractor may sign and date the Work Change Directive Authorization to indicate agreement with the terms.

1.06 DOCUMENTATION OF CHANGE PROPOSALS

A. Change proposal:
   1. Support with sufficient substantiating data to allow Engineer to evaluate the quotation.
      a. Lump sum.
      b. Unit prices: Use previously established unit prices.
      c. Time-and-material/force account basis:
         1) Name of the Owner's authorized agent who ordered the work, and date of the order.
         2) Dates and times work was performed, and by whom.
         3) Time record, summary of hours worked, and hourly rates paid.
         4) Receipts and invoices for:
            a) Equipment used, listing dates and times of use.
            b) Products used, listing of quantities.
            c) Subcontracts.
   2. Provide additional data to support time and cost computations:
      a. Labor required.
      b. Equipment required.
      c. Products required:
         1) Recommended source of purchase and unit cost.
         2) Quantities required.
      d. Taxes, insurance, and bonds.
      e. Credit for work deleted from Contract, similarly documented.
      f. Overhead and profit.
      g. Justification for change to Contract Time.

1.07 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS

A. Engineer will prepare each Change Order and Field Order.

B. Change Orders:
   1. Will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
   2. Will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.
   3. Recommendation of Change Proposal is indicated by Engineer's signature.
   4. Upon signature and execution by Owner, the Change Proposal becomes a Change Order altering the Contract Time and Total Contract Cost, as indicated.
      a. Owner's Representative will transmit one signed copy each to Contractor and Engineer.
   5. Contractor may only request payment for changes in the Work against an approved Change Order.
   6. If either Engineer or Owner's Representative disapproves the Change Proposal, the reason for disapproval will be stated.
      a. A request for a revised proposal or cancellation of the proposal will be shown.

C. Field Orders:
   1. Order minor changes in the Work without changes in Contract Price or Contract Times.

1.08 LUMP-SUM/FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's Proposal Request and Contractor's responsive Change Proposal as mutually agreed between Owner and Contractor.
   2. Contractor's Change Proposal for a change, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

C. Contractor will sign and date the Change Order to indicate agreement with the terms.

1.09 UNIT PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
   1. Engineer's definition of the scope of the required changes.
   2. Contractor's Change Proposal for a change, recommended by Engineer.
   3. Survey of completed work.

B. The amounts of the unit prices to be:
   1. Those stated in the Contract.
   2. Those mutually agreed upon between Owner and Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the work:
   1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.
   2. Contractor will sign and date the Change Order to indicate agreement with the terms.

D. When quantities of the items cannot be determined prior to start of the work:
   1. Engineer or Owner will issue a Work Change Directive authorization directing Contractor to proceed with the change on the basis of unit prices, and will cite the applicable unit prices.
   2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.
   3. Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.

E. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

F. Contractor will sign and date the Change Order to indicate their agreement with the terms.

1.10 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK CHANGE DIRECTIVE AUTHORIZATION

A. Engineer will issue a Work Change Directive for the Owner's signature authorizing Contractor to proceed with the changes.

B. At completion of the change, Contractor shall submit itemized accounting and supporting data as specified in this Section.

C. Engineer will determine the allowable cost of such work, as provided in the Contract Documents.

D. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

E. Contractor will sign and date the Change Order to indicate their agreement.

1.11 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Applications for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time. Revise subschedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01292

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Schedule of Values shall be a listing of all cost loaded, on-site construction activities from the progress schedule, listed in numerical order, showing that the sum total of all cost-loaded activities equal the Contract value.

B. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all cost-loaded activities continuously equal the current Contract value.
   1. Equate the aggregate of these costs to the Lump Sum Contract Price.

C. Prepare Schedule of Values identifying costs of Major Items of Work.

D. At a minimum, divide the work into following major items of Work:
   1. Mobilization/General Conditions.
   2. Contractor's Required QA/QC Testing.
   3. Filter Underdrain Replacement for Filters 1-6.
   4. Filter Nozzle Replacement for Filters 7-16.
   5. Filter Media Replacement.
   6. Filter Valve Replacement.
   7. Filter Launder Replacement.
   8. Backwash Supply Tank and Appurtenances.
   9. Chlorine Building:
      a. Structure.
      b. Process Equipment.
      c. HVAC Equipment.
      d. Electrical and Instrumentation Equipment.
   10. Caustic Building:
      a. Structure.
      b. Process Equipment.
      c. HVAC Equipment.
      d. Electrical and Instrumentation Equipment.
   11. Powdered Activated Carbon:
      a. Structure.
      b. Process Equipment.
      c. HVAC Equipment.
      d. Electrical and Instrumentation Equipment.

12. PEA, PC, and PEC Area:
    a. Structure.
    b. Process Equipment.
    c. Electrical and Instrumentation Equipment.
13. Primary Coagulant Building Modifications.
14. Fluoride Building Modifications.
15. Demolition:
    a. Primary Coagulant Building/Metering Area.
    b. Existing Chlorine Gas Storage Area.
16. Site Electrical Improvements (generator, transformers, switches, located outdoors).
17. New Asphalt.
18. Asphalt Maintenance.
19. Subgrade Repair.
20. Utility Vaults and Manholes.
21. Commissioning.
22. Demobilization.
23. Allowance Items, listed in Section 01210 - Allowances.
24. General Items, not included in other Major Items of Work:
    a. Earthwork and Grading.
    b. Miscellaneous Yard Piping.
    c. General Electrical Work.
    d. General Instrumentation Work.

1.03 SUBMITTALS

A. Submit Schedule of Values for the Preliminary Schedule as specified in Section 01321 - Schedules and Reports.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01294

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for preparation and submittal of Applications for Payment.

1.02 FORMAT

A. Fill in information required on form Payment Application and Certificate on page K-1 of Contract Documents.

B. After completing, submit Application for Payment.

C. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.

D. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

A. Provide Substantiating Data identifying:
   1. Project.
   2. Application number and date.
   3. Cost flow summary.
   4. Updated schedule of values.
   5. Progress schedule.
   6. Detailed list of enclosures.
   7. Stored products log.
   8. Equipment log.
   9. Submit “certified” payroll, if applicable.
   10. Record (as-built) documents.
   11. Applicable unconditional waiver and release on progress payment for previous payment made by Owner.

1.04 SUBMITTALS

A. Submit Application for Payment and Substantiating Data with cover letter and Payment Application and Certificate.

B. Use web-based construction document management system for submittal of Application of Payment and Substantiating data, as described in Section 01322 - Web Based Construction Document Management.

C. Comply with the requirements of Section 01330 - Submittal Procedures.

1.05 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis, in accordance with Section 14 of the general conditions. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format.

D. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.

E. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.

1.06 COST SUMMARIES

A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01312

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
      a. Qualifications of Meeting Participants.
      b. Basic Meeting Requirements.
      c. Pre-construction Conference.
      d. Pre-construction Safety Conference.
      e. Pre-submittal Conference.
      f. Web Based Construction Document Management Software Training.
      g. Progress Meetings.
      h. Schedule Update Meetings.
      i. Quality Control Meetings.
      j. Pre-Installation Meetings.
      k. Maintenance of Plant Operations (MOPO) Meetings.
      l. Commissioning Coordination Meetings.
      m. Instrumentation and Control Coordination Meetings.
      n. Close-out Meeting.
      o. Post Construction Meeting.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of the entity each represents.

1.03 BASIC MEETING REQUIREMENTS

A. Attendees:
   1. Meeting leader shall require attendance of parties directly affecting, or affected by, Work being discussed at the meeting.

B. Location:
   1. In location convenient for most invitees.

C. Notification:
   1. Meeting leader shall notify attendees of meeting, including an agenda, a minimum of 7 days prior to meeting.

D. Agenda:
   1. Meeting leader shall prepare copies of the agenda for participants and distribute at the meeting.

2. Minimum requirements:
    a. Meeting purpose.
    b. Review minutes of previous meeting.
    c. Safety and security.
    d. Discuss issues.
    e. Action items.
    f. Next meeting.

E. Meeting minutes:
    1. Meeting leader shall prepare draft minutes and send to attendees for comment within 7 days.
    2. Meeting leader shall incorporate comments from attendees and submit final meeting minutes to attendees within 7 days of receipt of comments.

1.04 PRE-CONSTRUCTION CONFERENCE

A. Construction manager leads the meeting.

B. Timing:
    1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable.

C. Required attendees:
    1. Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. To establish working understanding between parties and to discuss Construction Schedule, Shop Drawings and other Submittals, cost breakdown of major lump sum items, processing of Submittals and applications for payment, and other subjects pertinent to execution of the Work.
    2. Adequacy of distribution of Contract Documents.
    3. Distribution and discussion of list of major subcontractors and suppliers.
    4. Proposed progress schedules and critical construction sequencing.
    5. Major equipment deliveries and priorities.
    6. Project coordination.
    7. Designation of responsible personnel.
    8. Procedures and processing of:
        a. Field decisions.
        b. Proposal requests.
        c. Submittals - separate meeting.
        d. Change Orders.
        e. Request for Information/Interpretations.
        f. Applications for Payment.
        g. Record documents.
    9. Use of premises:
        a. Office, construction, and storage areas.
        b. Owner's requirements.
    10. Construction facilities, controls, and construction aids.

11. Temporary utilities.
12. Safety and first aid procedures.
13. Security procedures.
14. Housekeeping procedures.
15. Safety and security.
16. Review proposed photographer Submittal.
17. Action items.
18. Next meeting.

1.05 PRE-CONSTRUCTION SCHEDULING MEETING

A. Construction manager leads the meeting.

B. Timing:
   1. Within 7 days of Notice to Proceed, or earlier when mutually agreeable.

C. Required attendees:
   1. Contractor's project manager, superintendent, scheduler, Owner, Engineer, and others necessary to the agenda.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. To establish the format and features of the Construction Schedule.
   2. Schedule preparation.
   3. Reporting requirements.
   4. Updates and revision procedures.
   5. Schedule delay analysis procedures.
   6. Schedule methodology.
   7. Planned sequence of operations.
   8. Cost and labor loading methodology.
   9. Proposed activity coding structure as specified in Section 01321 - Schedules and Reports.
   10. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule.
      a. Example 1: 2021_07_30 rev 1 draft baseline schedule.xer.
      b. Example 2: 2021_09_30 rev 2 sep final update.xer.
   11. Action items.
   12. Next meeting.

1.06 PRE-CONSTRUCTION SAFETY CONFERENCE

A. Construction manager leads the meeting.

B. Timing:
   1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable.

C. Required attendees:
   1. Contractor's project manager, safety representative, and superintendent; Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. To establish safety procedures and identify lead participants.
    2. Review minutes of previous meeting.
    3. Safety and first aid procedures.
    4. Review of Experience Modification Rating for Contractor and each Subcontractor.
    5. Security procedures.
    6. Housekeeping procedures.
    7. Safety and security.
    8. Action items.
    9. Next meeting.

1.07 PRE-SUBMITTAL CONFERENCE

A. Construction manager leads the meeting.

B. Timing:
    1. Prior to producing any Submittals.

C. Required attendees:
    1. Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors, individual equipment manufacturers furnishing major pieces of equipment, and others involved in performance of the Work, and others necessary to the agenda.

D. Agenda minimum requirements:
    1. Meeting purpose:
        a. Review the entire Project, equipment, control philosophy, schedules, and Submittal requirements.
        b. Awareness of requirements by major subcontractors, major suppliers, and major equipment manufacturers.
        c. Format and procedures for Submittals.
        d. Review of the master Submittal schedule.
    2. Review equipment list.
    3. Review Submittal schedule.
    4. Format of Submittals.
    5. Procedures and processing of Submittals.
        a. Review turn-around time.
    6. Discuss specific electrical and instrumentation and controls Submittal requirements.
    7. Safety and security.
    8. Action items.
    9. Next meeting.

1.08 WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT SOFTWARE TRAINING

A. Contractor can submit a written request to the Engineer to waive the training based on staff having sufficient familiarity with the software and its complete usage. Construction manager will lead the meeting. See Section 01322 for further information.

B. Timing:
   1. Upon issuance of Notice to Proceed, or earlier when mutually agreeable,
   2. Duration minimum: 2 hours.

C. Required attendees:
   1. Mandatory attendance.
      a. Contractor's project manager.
      b. Contractor's field superintendent.
      c. Contractor's project engineer.
   2. Other attendees:
      a. Owner, Engineer, Contractor's quality control manager, Contractor's project scheduler and any other persons involved with preparing and transmitting documents.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Train construction team on the use of the web based document management system software.
   2. Safety.
   3. General Items.
   4. Contractor functions.
   5. Owner functions.
   6. Engineer functions.
   7. Action items.

1.09 PROGRESS MEETINGS

A. Construction manager will lead the meeting.

B. Timing:
   1. Hold meetings throughout progress of the Work at maximum weekly intervals.

C. Required attendees:
   1. Owner, Engineer, Contractor, Contractor's project manager, superintendent, quality control manager, project scheduler, major subcontractors and suppliers as appropriate to the agenda topics for each meeting.
   2. Additional invitees:
      a. Owner utility companies when the Work affects their interests, and others necessary to the agenda.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Provide the status of the Work.
   2. Review minutes of previous meeting.
   3. Safety and security.
   4. Construction schedule summary.
   5. Review of 6 weeks schedule.
      a. Contractor shall provide printed hard copies for each attendee.
   6. Review of off-site fabrication and delivery schedules.
   7. Review of Submittals schedule and status of Submittals.
   8. Request for information (RFI's) status.

9. MOP's/shutdown coordination.
10. Change order management status.
11. Maintenance of quality standards (QA/QC).
12. Field observations, problems, and conflicts.
13. Commissioning.
14. Partnering recognition status (optional).
15. General items.
16. Action items.
17. Next meeting.

1.10 SCHEDULE UPDATE MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Hold meetings throughout progress of the Work at maximum monthly intervals.

C. Required attendees:
   1. Owner, Engineer, Contractor, Contractor's project manager, general superintendent, project scheduler, major subcontractors and suppliers as appropriate to the agenda topics for each meeting.
   2. Additional invitees:
      a. Owner utility companies when the Work affects their interests and others necessary to the agenda.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Identify and troubleshoot scheduling issues in a collaborative environment.
      b. Provide further detail on Work status.
   2. Review minutes of previous meeting.
   3. Review Monthly Schedule, (Actual Progress and Variance).
      a. "Activities Started/Completed" this period.
      b. "Activities Started/Completed" "Variance" Baseline vs. current.
      c. "Added/Deleted Activities".
      d. "Revised Activity Descriptions".
      e. Any significant Proposed Logic Changes.
   4. Review milestone "Substantial Completion" Schedule:
      a. "Critical" Activities - "Critical Area, Float and Vital Statistics".
   5. Review "Cumulative and Monthly Costs" graph.
   6. Review "Budgeted Cost" indicating the Current Project Budgeted Cost.
   7. Safety and security.
   8. Action items.
   9. Next meeting.

1.11 PRE-INSTALLATION MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. When specified in Technical Sections or requested by Engineer, before commencing Work of specific section.

C. Required attendees:
   1. Owner, Engineer, Contractor, Contractor's project manager, general superintendent, project scheduler, major subcontractors including electrical instrumentation, and suppliers as appropriate to the agenda topics for each meeting.
   2. Additional invitees:
      a. Owner utility companies when the Work affects their interests and others necessary to the agenda.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Review conditions of installation, preparation, and installation procedures.
      b. Review coordination with related work.
   2. Review minutes of previous meeting.
   3. Safety and security.
   4. Action items.
   5. Next meeting.

1.12 PRE-SHUTDOWN MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Short-term and longer-term shutdowns and other tie-ins that require an Owner approved MOP require a pre-shutdown meeting at Project site at least 6 working days prior to commencing shutdown for tie-in or modification of specific plant systems.

C. Required attendees:
   1. Require attendance of parties directly affecting, or affected by shutdown, including Engineer, specific work crews, Owner's construction, operations, and maintenance staff.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Review conditions of installation, preparation, and installation procedures.
      b. Review coordination with related work.
   2. Review minutes of previous meeting.
   3. Review accepted Construction Method of Procedure (MOP), as specified in Attachment A of Section 01140 - Work Restrictions, including conditions of shutdown, preparation, and installation procedures.
   4. Review timelines and sequences.
   5. Review responsibilities.
   6. Review dry run plan and schedule, as necessary.
   7. Review coordination with related work.
   8. Safety and security.
   9. Action items.
   10. Next meeting.

1.13 QUALITY CONTROL MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Hold meetings throughout progress of the Work at maximum weekly intervals.

C. Required attendees:
   1. Engineer, Construction manager and staff, Contractor's quality control manager, and staff.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Update Contractor's efforts to comply with quality requirements in the Contract Documents.
   2. Review minutes of previous meeting.
   3. Review of Work progress and schedule.
   4. Review of out-of-compliance inspection or test results.
   5. Field observations, problems, and decisions.
   6. Review of offsite fabrication and delivery schedules.
   7. Planned progress during succeeding work period.
   8. Coordination of required inspections and tests.
   9. Review 6-week schedule report with upcoming inspections and special tests.
   10. Maintenance of quality and work standards.
   11. Other business relating to Work.
   12. Safety and security.
   13. Action items.
   14. Next meeting.

1.14 COMMISSIONING COORDINATION MEETINGS

A. Contractor leads the meeting.

B. Timing:
   1. Separate commissioning coordination meetings will be scheduled as required by the Engineer.

C. Required attendees:
   1. Require attendance of parties directly affecting, or affected by process start-up and testing, including Engineer, Commissioning Coordinator, specific work crews, Owner's operations, and maintenance staff.

D. Agenda minimum requirements:
   1. Meeting purpose:
      a. Coordinate commissioning activities.
   2. Review minutes of previous meeting.
   3. Review Commissioning schedule.
   4. Review Owner Training schedule.
   5. Review test plans.
   6. Review accepted Construction Method of Procedure (MOP), as specified in Attachment A of Section 01140 - Work Restrictions.

7. Owner makes final decision for commissioning GO or NO GO.
8. Safety and security.
9. Action items.
10. Next meeting.

1.15 INSTRUMENTATION AND CONTROL COORDINATION MEETINGS

A. Meetings and conferences as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.16 CLOSE-OUT MEETING

A. Construction manager leads the meeting.

B. Timing:
1. After punch list items are completed.

C. Required attendees:
1. Owner, Engineer, Contractor, Contractor's project manager, and superintendent.

D. Agenda minimum requirements:
1. Meeting purpose:
a. Coordinate close-out activities.
2. Review minutes of previous meeting.
3. Review punch list completion.
4. Transfer of record documents.
5. Finalize payment.
6. Safety and security.
7. Action items.
8. Next meeting.

1.17 POST CONSTRUCTION MEETING

A. Construction manager leads the meeting.

B. Timing:
1. About 11 months after date of Substantial Completion.

C. Location:
1. Meet in Owner's office or other mutually agreed upon place.

D. Required attendees:
1. Engineer, Contractor, appropriate manufacturers, and installers of major units of constructions, affected Subcontractors, and Owner's operations and maintenance staff.

E. Agenda minimum requirements:
1. Meeting purpose:
a. Review Project for compliance with the Contract Documents.
2. Inspect the Work and draft list of items to be completed or corrected.

3. Review service and maintenance contracts and take appropriate corrective action when necessary.
4. Complete or correct defective work and may extend correction period.
5. Safety and security.
6. Action items.
7. Next meeting.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01321

SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Schedules and reports.

1.02 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Baseline schedule: A planned and approved timetable projection that illustrates the project execution strategy, key deliverables, planned activity dates and milestones.
   2. Critical path: The longest sequence of dependent tasks in a project.
   3. Near critical path: The longest path after the critical path.
   4. Weather day: The Contractor being prevented or inhibited from performing at least 4 hours of work on the critical path due to weather conditions.

1.03 SCHEDULING FORMAT

A. Utilize critical path method (CPM) format.

B. Provide a cost and labor loaded Schedule.

C. Engineer approval of the format is required.

1.04 SCHEDULING HARDWARE AND SOFTWARE

A. Prepare computerized schedule utilizing the most current version of Oracle Primavera P6 or Asta Powerproject. Use of any other software must be approved by the Owner and Engineer.

B. Contractor and Engineer must agree on the format.

1.05 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor’s intention to execute the Work within specified time and constraints.

B. All costs associated with Schedule requirements are included in the Contract Price.

C. During preparation of the preliminary Progress Schedule, the Engineer will facilitate Contractor’s efforts by answering questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare Schedule utilizing precedence diagramming method (PDM).

E. Prepare Schedule utilizing activity durations in terms of working days.
   1. Do not exceed a 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
   2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
   3. Coordinate holidays to be observed with the Owner and incorporate them into the Schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract.
   1. Contract requirements are not waived by failure of Contractor to include required Schedule constraints, sequences, or milestones in Schedule.
   2. Contract requirements are not waived by Owner's acceptance of the Schedule. In the event of conflict between accepted Schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference Schedule to working days beginning with Notice to Proceed as Contract Time as Day "1".

H. Baseline Schedule and project completion:
   1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor's Schedule completion date.
   2. Adjust accordingly any Contract milestone dates.

I. Imposed dates and hidden logic are prohibited.

J. Interim milestone dates, operational constraints:
   1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on Schedule.
   2. Do not use zero total float constraint or mandatory finish date on such Contract requirements.

K. Contract float is for the mutual benefit of both Owner and Contractor.
   1. Changes to the Project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time by utilizing float.
   2. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date.
   3. Likewise, Contractor may utilize float to offset delays other than delays caused by the Owner.
   4. Mutual use of float can continue until all available float shown by Schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.

5. Non-sequestering of float: Pursuant to float sharing requirements of Contract, Schedule submittals can be rejected for use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations, or imposed dates.

L. Resource loading and leveling:
   1. Input labor data on each schedule activity.
   2. Manpower data consists of the man-hours estimated to perform each task, categorized by trade.
   3. Provide leveled manpower requirements.
      a. Availability of the resources drive activity duration.

M. Cost loading: All schedules:
   1. Only on-site construction activities.
   2. The sum total of all cost loaded activities equal to the current value of the Contract, including change orders, at all times.
   3. Payment for mobilization or payment for materials or equipment delivered to the site, not yet incorporated into the Work.
   4. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01292 - Schedule of Values.
   5. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01294 - Applications for Payment.
   6. Payments will not be made until the updated Schedule of Values is accepted.

N. Schedule logic:
   1. Assembled to show order in which Contractor proposes to carry out Work, indicate restrictions of access, availability of Work areas, and availability and use of manpower, materials, and equipment.
   2. Form basis for assembly of schedule logic on the following criteria:
      a. Which activities must be completed before subsequent activities can be started?
      b. Which activities can be performed concurrently?
      c. Which activities must be started immediately following completed activities?
      d. What major facility, equipment, or manpower restrictions are required for sequencing these activities?

1.06 SCHEDULER

A. Designate, in writing within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.

B. Scheduler shall have the authority to update Schedule on behalf of the Contractor.

C. Qualifications:
   1. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
   2. Knowledge of critical path method (CPM) scheduling utilizing the specified software.

D. Scheduler:
   1. Dedicated half time to this Project.
   2. Scheduler will attend all project meetings called for as specified in Section 01312 - Project Meetings.

1.07 SUBMITTAL REQUIREMENTS

A. Preliminary and Baseline Progress Schedule.

B. Preliminary and Baseline Schedule of Values.

C. Preliminary and Baseline Schedule of Submittals.

D. On a monthly basis, updated Schedules as specified.

E. Final Schedules update as specified.

F. Revised Schedules and time impact analyses as specified.

G. Submit Schedules in the media and number of copies as follows:
   1. PDF format and other formats specified in this Section.
   2. 2 sets of CPM Schedule data electronic files in a native backed-up file format.

1.08 GANTT CHART

A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram.
   1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished.
   1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.

D. Provide Progress Schedule showing the critical path for the Project.

E. Provide report of Near Critical Path activities for the Project, when required by the Engineer.

F. Delineate the specified Contract Times and identify the planned completion of the Work as a milestone.
   1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as Project float.

G. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion dates as milestones.

H. Produce electronic network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

I. Identify the execution of the following:
   1. Mobilization.
   2. All required Submittals and Submittal review times showing 30 calendar day duration for such activities and equal amount of time for resubmittal reviews.
   3. Equipment and materials procurement/fabrication/delivery.
   4. Excavation.
   5. Shoring design and submission of detailed shoring submittals. Identify submission as a milestone.
   6. Shoring review, shoring materials procurement, shoring installation, and shoring removal.
   7. Piles.
   8. Backfill and compaction.
   9. Dewatering.
   10. Grading, subbase, base, paving, and curb and gutters.
   11. Fencing and landscaping.
   12. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
   13. Tests for leakage of concrete structures intended to hold water.
   14. Masonry.
   15. Metal fastenings, framing, structures, and fabrications.
   16. Wood structures, finish carpentry, architectural woodwork, and plastic fabrications.
   17. Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.
   18. Doors and windows, including hardware and glazing.
   19. Finishes including coating and painting, flooring, ceiling, and wall covering.
   20. Building specialties including furnishings, laboratory equipment, and toilet and bath accessories.
   21. Process equipment, including identification of ordering lead-time, factory testing, and installation.
   22. Pumps and drives, including identification of ordering lead time, factory testing, and installation.
   23. Conveying equipment including hoists and cranes, conveyor systems, and materials handling equipment, including identification of ordering lead-time and installation.
   24. Other mechanical equipment including fans and heating, ventilating, and air conditioning equipment.
   25. Trenching, pipe laying, and trench backfill and compaction.
   26. Piping, fittings, and appurtenances, including identification of ordering and fabrication lead time, layout, installation and testing.
   27. Valves, gates, and operators, including identification of order lead-time, installation, and testing.
   28. Plumbing specialties.
   29. Electric transmission, service, and distribution equipment, including identification of ordering lead-time, and factory testing.
   30. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
   31. Instrumentation and controls, including identification of ordering lead-time.

32. Preliminary testing of equipment, instrumentation, and controls.
33. Commissioning phase:
    a. Source Testing.
    b. Owner Training.
    c. Installation Verification.
    d. Functional Testing.
    e. Start-up Phase.
    f. Start-up Period.
34. Instrumentation and Controls Performance Testing.
35. Substantial completion.
36. Punch list work.
37. Demobilization.

1.09 PRELIMINARY SCHEDULE

A. Procedure:
    1. Submit proposed Preliminary Schedule within 14 calendar days after Notice to Proceed.
    2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule to review and make necessary adjustments.
    3. Submit revised Preliminary Schedule within 5 calendar days after meeting.
    4. Update Preliminary Schedule monthly until the Baseline Schedule is accepted.

B. Format:
    1. Simplified Gantt chart.

C. Activities:
    1. Define activities to be completed in the first 90 calendar days of Work.
    2. Actualize activities performed during the first 90 days into the first monthly Schedule update.

1.10 PRELIMINARY SCHEDULE OF VALUES

A. Preliminary Schedule of Values as specified in Section 01292 - Schedule of Values.

B. Procedure:
    1. Submit proposed Preliminary Schedule of Values within 14 calendar days after Notice to Proceed.
    2. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule of Values to review and make necessary adjustments.
    3. Submit revised Preliminary Schedule of Values within 5 calendar days after meeting.

1.11 WORK WITHIN THE FIRST 90 DAYS

A. Proceed with Work after Preliminary Schedule and Preliminary Schedule of Values have been accepted by Owner.

B. Submittal and acceptance of Preliminary Schedule and Preliminary Schedule of Values is condition precedent to making of progress payments as specified in

Section 01294 - Applications for Payment and payments for mobilization costs otherwise provided for in the Contract.

1.12 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include Submittals required in the Contract Documents but not limited to test plans, training plans, test procedures, operation and maintenance manuals, Shop Drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.

B. Preliminary Schedule of Submittals:
   1. Due date: After Preliminary Schedule has been submitted and accepted by the Owner.
   2. Format:
      a. Include Submittals anticipated in the first 90 calendar days after award of Contract using early start dates.
      b. Indicate week and month anticipated for submittal to Engineer.
      c. Indicate “Priority” Submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” Submittals where possible.
   3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after award of Contract.

C. Final Schedule of Submittals:
   1. Due date: 30 days after Baseline Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include Submittals using early start dates.
      b. Include all Submittals, including those required in the Preliminary Schedule of Submittals.
      c. Indicate week and month anticipated for submittal to Engineer.
      d. Indicate “Priority” submittals where review time can impact Contractor’s schedule.
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” Submittals where possible.
   3. Submittal of final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if Schedule revisions change listing and timing of Submittals.

1.13 BASELINE PROGRESS SCHEDULE AND BASELINE SCHEDULE OF VALUES

A. Due date: No more than 45 calendar days after Notice to Proceed.

B. Format:
   1. Progress Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
   2. Schedule of Values: As specified in Section 01292 - Schedule of Values.

C. Acceptance of the Baseline Progress Schedule and Baseline Schedule of Values by the Owner is a condition precedent to making payments as specified in Section 01294 - Applications for Payment after the first 90 calendar days after Notice to Proceed.

1.14 SUMMARY SCHEDULE

A. Due date: At weekly progress meetings and after each Schedule update or Schedule revision.

B. Format:
   1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
   2. Intended to give an overall indication of the Project Schedule without a large amount of detail.

1.15 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

A. Due date: Submit on a monthly basis as specified in Section 01294 - Applications for Payment.

B. Format: As specified in Section 01292 - Schedule of Values.

1.16 WEEKLY SCHEDULE

A. Due date: At every weekly progress meeting.

B. Format:
   1. Contractor and Engineer must agree on the format.
   2. 6-week Schedule showing the activities completed during the previous week and the Contractor’s schedule of activities for following 5 weeks.
   3. Use the logic and conform to the status of the current Progress Schedule when producing a weekly Schedule in CPM schedule or a bar chart format.
      a. In the event that the weekly Schedule no longer conforms to the current Schedule, Contractor may be required to revise the Schedule as specified in this Section.
   4. Activity designations used in the weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule updates.

1.17 COMMISSIONING SCHEDULE

A. Commissioning activities and milestones, as specified in Section 01756 - Commissioning, shall be an integral part of the overall Progress Schedule.
   1. Commissioning activities and milestones shall be extracted from the Progress Schedule to provide a separate Commissioning schedule that is submitted each time the Progress Schedule is submitted.

B. Proposed Commissioning Schedule:
   1. Schedule requirements: As specified in Section 01756 - Commissioning.
   2. Submittal due date: Within 120 days after Notice to Proceed.
   3. Engineer response due within 20 calendar days of receipt.
   4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.

C. Construction Schedule can include the Commissioning Schedule after Engineer acceptance of the Proposed Commissioning Schedule.
   1. Capable of extracting a stand-alone Commissioning Schedule.
   2. Capable of extracting a stand-alone Owner Training Schedule.

D. Monthly update requirements:
   1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.
   2. Include activities not previously included in the previously accepted detail work plan Commissioning Schedule.
   3. Change Order required for any change to contractual dates.
   4. Reviews of these Submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

1.18 PRE-CONSTRUCTION SCHEDULING MEETING

A. As specified in Section 01312 - Project Meetings.

1.19 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review preliminary Schedules, Schedule updates, Schedule revisions, and time impact analyses to ascertain compliance with specified project constraints, compliance with milestone dates, durations and sequence, accurate interrelationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of baseline Schedules within 21 calendar days after receipt.

C. Written comments on review of Schedule updates and Schedule revisions and time impact analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit Schedules in accordance with Engineer’s comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.

E. If the Engineer requests a meeting, the Contractor and all major subcontractors shall participate.
   1. Revise and resubmit Schedule within 7 calendar days after meeting.

F. Use accepted Schedules for planning, organizing, and directing the Work and for reporting progress.

G. Engineer's Submittal review response:
   1. When Schedules reflects the Owner's and Contractor's agreement of project approach and sequence, Schedules will be accepted by the Owner.
   2. Engineer's Submittal review response for Schedule Submittals will be "Receipt Acknowledged - Filed for Record".
   3. Acceptance of the Schedules by the Owner is for general conformance with the Contract Documents and for the Owner's planning information and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the Contract completion dates.
      a. Omissions and errors in the accepted Schedules shall not excuse performance less than that required by the Contract Documents.
      b. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.20 SCHEDULE UPDATES

A. Any update:
   1. Prepare update using most recent accepted version of Schedule including:
      a. Actual start dates of activities that have been started.
      b. Actual finish dates of activities that have been completed.
      c. Percentage of completion of activities that have been started but not finished.
      d. Actual dates on which milestones were achieved.
      e. Update activities by inputting percent complete figures with actual dates.
      f. Use retained logic in preparing Schedule updates.
      g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
      h. Revisions to the Schedule may be included that have been previously approved as specified.

B. Monthly updates:
   1. Submit written narrative report in conjunction with each Schedule update, including descriptions of the following:
      a. Activities added to or deleted from the Schedule are to adhere to cost and other resource loading requirements.
         1) Identify added activities in manner distinctly different from original activity designations.
      b. Changes in sequence or estimated duration of activities.
      c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
      d. Assumptions made and activities affected by incorporating change order work into the Schedule.

e. Include a response in writing to each of the Engineer's comments or questions from the previous month's schedule review and number responses consistent with the Engineer's numbering.

2. Submit updated Schedule and materials specified under Submittal of Progress Schedules 5 calendar days before the monthly schedule update meeting.
3. Since monthly Schedule update is the application for progress payment required as specified in Section 01294 - Applications for Payment, submittal and acceptance of the monthly Schedule update is a condition precedent to the making of any progress payments.

C. Weekly progress meeting:
1. Update the Schedule prior to weekly progress meeting.
   a. Identify overall progress of each major item of work in the summary schedule.
   b. If there are significant changes to the Schedule, submit a written report at the weekly progress meeting.
2. Should monthly Schedule update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as "Project Float".
3. Should monthly Schedule update show Project completion later than current Contract completion date, prepare and submit a Schedule revision.

1.21 REVISIONS TO SCHEDULES

A. Submit revised Schedules within 5 days:
1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
2. When delays in Submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
3. When the Schedule does not represent the actual progress of activities.
4. When any change to the sequence of activities, the completion date for major portions of the Work, or when changes occur which affect the critical path.
5. When Contract modification necessitates Schedule revision, submit schedule analysis of Change Order work with cost proposal.

B. Create a separate Submittal for Schedule revisions.
1. Comply with Schedule updates as specified in this Section.
2. Do not submit with Schedule updates.

C. Schedule revisions will not be reflected in the Schedule until after the revision is accepted by the Owner.
1. This includes Schedule revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.22 ADJUSTMENT OF CONTRACT TIME OR PRICE

A. Contract Time will be adjusted only for causes specified in Contract Documents.

B. If the Contractor believes that the Owner has impacted its work such that the Project completion date will be delayed, the Contractor must submit proof, in the form of a time impact analysis demonstrating the delay to the critical path.

C. Time impact analysis:
   1. Use the accepted Schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the Schedule by:
      a. Inserting new activities associated with the delay event into the Schedule.
      b. Revising activity logic.
      c. Revising activity durations.
   2. If the Progress Schedule's critical path and completion date are impacted as a result of adding this delay event to the Progress Schedule, a time extension equal to the magnitude of the impact may be warranted.
   3. The time impact analysis Submittal must include the following information:
      a. A fragment of the portion of the Schedule affected by the delay event.
      b. A narrative explanation of the delay issue and how it impacted the Schedule.
      c. A schedule file used to perform the time impact analysis.

D. When a delay to the Project as a whole can be avoided by revising preferential sequencing or logic and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the Contractor has used, in full, all project float available for the Work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date.
   1. Utilize the latest version of the Schedule update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Adjustment of the Contract Times will be granted only when the Contract float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date.
   1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.

G. Actual delays in activities which do not affect the Critical Path Work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to jobsite or home office overhead beyond the Contractor's originally planned occupancy of the site.

I. Notify Engineer of a request for Contract Time adjustment.
   1. Submit request as specified in the Contract Documents.
   2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change

order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

J. Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing.
   1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule update.
   2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
   3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
   4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.23 WEATHER DAY ALLOWANCE

A. Allowance:
   1. Include as a separate identifiable activity on the critical path, an activity labeled “Weather Day Allowance.”

B. Actual Weather Day:
   1. Insert a weather delay activity in the critical path to reflect actual weather day occurrences when weather days are experienced and accepted by the Engineer.
   2. Reduce duration of Weather Day Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in the Weather Day Allowance at completion of the Project is considered float.
   3. Provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted.
      a. A Schedule update will not suffice as a written notice.
      b. Engineer will determine if the Weather Day constitutes a use of a portion of the Weather Day Allowance.
      c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.

1.24 FINAL SCHEDULE

A. The final Schedule update becomes the As-Built Schedule.
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.

2. Contractor's Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule update is provided.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01322

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for web-based construction document management.

1.02 REQUIREMENTS

A. Owner, Engineer, construction manager, and Contractor shall utilize the specified Autodesk Build, web-based construction management software, for submission of data and documents.
   1. Web-based construction management software is available at no cost to Contractor's personnel, subcontractor personnel, Suppliers, consultants, Owner, construction manager, and Engineer.
   2. Joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
   3. Web based construction management software shall be the primary means of project information submission and management.

1.03 USER ACCESS LIMITATIONS

A. Provide a list of Contractor's key web based construction management software personnel for the Engineer's acceptance.

B. Engineer reserves the right to perform a security check on potential users.
   1. Contractor will be allowed to add additional personnel and subcontractors to the web-based construction management software.
   2. Subcontractors and Suppliers will be given access to web-based construction management software by and through the Contractor.
   3. Contractor is responsible for adding and removing users from the system after the initial setup by the Engineer.

C. Engineer will grant initial access to the web-based construction management software by creating user profiles to accepted Contractor personnel.
   1. User profiles will define levels of access into the system; determine assigned function based authorizations and user privileges.

1.04 JOINT OWNERSHIP OF DATA

A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the web-based construction management software system) by Engineer and Contractor will be jointly owned.

1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents.

B. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents.

C. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.06 COMPUTER REQUIREMENTS

A. Contractor shall use computer hardware and software that meets the requirements of the web-based construction management software system as recommended by the web-based construction management software to access and utilize the web-based construction management software.

B. As recommendations are modified by the web-based construction management software, Contractor will upgrade their system(s) to meet or exceed the recommendations.
   1. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.

C. Ensure that connectivity to the web-based construction management software system is accomplished through DSL, cable, T-1 or wireless communications systems.
   1. Minimum bandwidth requirements for using the system is 5 Mbps. It is recommended a faster connection be used when uploading pictures and files into the system.

D. Web-based construction management software supports the current version of Chrome (preferred), Mozilla's Firefox, Microsoft Edge, and Apple's Safari on a rolling basis.
   1. Each time a new version of one of these browsers is released, the web-based construction management software will begin supporting the update and stop supporting the fourth-oldest version.

1.07 CONTRACTOR RESPONSIBILITY

A. Responsible for the validity of their information placed in the web-based construction management software and for the abilities of their personnel.

B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on the web-based construction management software shall be the responsibility of the Contractor.

C. Accepted users shall be knowledgeable in the use of computers, including Internet browsers, email programs, CAD drawing applications, and Adobe Portable Document Format (PDF) document distribution program.

D. Utilize the existing forms in the web-based construction management software to the maximum extent possible. If a form does not exist in the web-based construction management software, Contractor must include a form of their own or provided by the Engineer as an attachment to a Submittal.

E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of the web-based construction management software (outside what is provided by the Owner) and the other programs indicated above as needed.

1.08 TRAINING

A. Owner has arranged and paid for web-based training on using web-based construction management software for the Contractor.

B. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate Contractor's training.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. Web-based construction management software provided by Autodesk Build.

PART 3 EXECUTION

3.01 WEB-BASED CONSTRUCTION MANAGEMENT SOFTWARE UTILIZATION

A. Web-based construction management software shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

A. Use the web-based construction management software feature for Master Submittals List.
   1. Select from the predefined submittals list.

B. Content: As specified in Section 01330 - Submittal Procedures.

C. Format: As specified in Section 01330 - Submittal Procedures.

D. Submit Portable Document Format (PDF) documents to the web-based construction management software submittal workflow process and forms.
   1. Consolidate electronic format submittals with multiple pages into a single file.

E. Samples:
   1. Enter Submittal data information into the web-based construction management software.
   2. Attach a copy of the submittal form(s) to the sample.

F. Record and Closeout Submittals:
   1. Operation and maintenance data as specified in Section 01782 - Operation and Maintenance Manuals.
   2. Extra materials, spare parts, etc.

3.03 REQUESTS FOR INFORMATION/INTERPRETATION (RFI)

A. Use web-based construction management software for RFIs as specified in Section 01260 - Contract Modification Procedures.

3.04 OFFICIAL CORRESPONDENCE

A. Use web-based construction management software for memos, notices, change proposals, or any official correspondence.

3.05 INSPECTION REQUESTS

A. Use web-based construction management software to request inspection for a portion of Work that is ready for inspection and prior to covering up the Work.

3.06 FINANCIAL SUBMITTALS

A. Use web-based construction management software for financial submittals as specified in Section 01330 - Submittal Procedures.

3.07 OTHER

A. Use web-based construction management software for daily reports, meeting agendas and minutes, and other construction documents.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements and procedures for Submittals to confirm compliance with Contract Documents.

1.02 GENERAL INSTRUCTIONS

A. Contractor is responsible to determine and verify field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved Shop Drawings and Contract Document requirements.

B. Provide Submittals:
   1. That are specified or reasonably required for construction, operation, and maintenance of the Work.
   2. That demonstrate compliance with the Contract Documents.

C. Where multiple Submittals are required, provide a separate Submittal for each Specification section.
   1. In order to expedite construction, the Contractor may make more than one Submittal per Specification section, but a single Submittal may not cover more than one Specification section:
      a. The only exception to this requirement is when one Specification section covers the requirements for a component of equipment specified in another section.
      b. For example, circuit breakers are a component of switchgear. The switchgear Submittal must also contain data for the associated circuit breakers, even though they are covered in a different Specification section.

D. Prepare Submittals in the English language. Do not include information in other languages.

E. Present measurements in customary American units (feet, inches, pounds, etc.).

F. Must be clear and legible, and of sufficient size for presentation of information.

G. Page size, other than drawings:
   1. Minimum: 8 1/2 inches by 11 inches.
   2. Maximum: 11 inches by 17 inches.

H. Drawing sheet size:
   1. Maximum: 22 inches by 34 inches.
      a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8-inch.
   2. 11-inch by 17-inch sheet:
      a. Minimum plan scale: 1/8 inch equals 1 foot-0 inches.
      b. Minimum font size: 1/8-inch.

I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.

J. Provide Submittal information from only one manufacturer for a specified product. Submittals with multiple manufacturers for one product will be rejected without review.

1.03 SUBMITTAL ORGANIZATION

A. Organize Submittals in exactly the same order as the items are referenced, listed, and/or organized in the Specification section.

B. For Submittals that cover multiple devices used in different areas under the same Specification section, the Submittal for the individual devices must list the area where the device is used.

C. Bookmarks:
   1. Bookmarks shall match the table of contents.
   2. Bookmark each section (tab) and heading.
   3. Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
   4. At file opening, display all levels of bookmarks as expanded.

D. Where applicable (i.e., except for Drawings, figures, etc.), Submittal content shall be electronically searchable utilizing the PDF file as submitted.

E. Thumbnails optimized for fast web viewing.

F. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.

G. Attachments:
   1. Include with each Submittal a copy of the relevant Specification section.
      a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   2. Include with each Submittal a copy of the relevant Drawing, including relevant addendum updates.
      a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).

b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

H. Contractor: Prepare Submittal information in sufficient detail to show compliance with specified requirements.
1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
2. Coordinate Submittal with other Submittals and with the requirements of the Contract Documents.
3. Check, verify, and revise Submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

I. Contractor: Prepare “Or Equal” Submittal information in accordance with the General Conditions and requirements below.
1. Provide standard Submittal requirements.
a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
2. Provide reason the specified product is not being provided.
3. Explain the benefits to the Owner for accepting the “Or Equal”.
4. Itemized comparison of the proposed “Or Equal” with product specified including a list of significant variations:
a. Design features.
b. Design dimensions.
c. Installation requirements.
d. Operations and maintenance requirements.
e. Availability of maintenance services and sources of replacement materials.
5. Reference projects where the product has been successfully used:
a. Name and address of project.
b. Year of installation.
c. Year placed in operation.
d. Name of product installed.
e. Point of contact: Name and phone number.
6. Define impacts:
a. Impacts to other contracts.
b. Impacts to other work or products.
7. Contractor represents the following:
a. Contractor bears the burden of proof of the equivalency of the proposed “Or Equal”.
b. Proposed “Or Equal” is equal or superior to the specified product.
c. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed “Or Equal,” unless Owner requires a Special Warranty.
d. Contractor will coordinate installation of accepted “Or Equal” into the Work and will be responsible for the costs to make changes as required to the Work.
e. Contractor waives rights to claim additional costs caused by proposed “Or Equal” which may subsequently become apparent.

J. Contractor: Prepare substitution Submittal information in accordance with the General Conditions and requirements below.
    1. Provide standard Submittal requirements.
        a. In addition, provide in sufficient detail to show reason for variance from specified product and impacts.
    2. Provide reason the specified product is not being provided.
    3. Explain the benefits to the Owner for accepting the substitution.
    4. Itemized comparison of the proposed substitution with product specified including a list of significant variations:
        a. Design features.
        b. Design dimensions.
        c. Installation requirements.
        d. Operations and maintenance requirements.
        e. Availability of maintenance services and sources of replacement materials.
    5. Reference projects where the product has been successfully used:
        a. Name and address of project.
        b. Year of installation.
        c. Year placed in operation.
        d. Name of product installed.
        e. Point of contact: Name and phone number.
    6. Define impacts:
        a. Impacts to Contract Price.
            1) Required license fees or royalties.
            2) Do not include costs under separate contracts.
            3) Do not include Engineer’s costs for redesign or revision of Contract Documents.
        b. Impacts to Contract Time.
        c. Impacts to Contract Scope.
        d. Impacts to other contracts.
        e. Impacts to other work or products.
    7. Contractor represents the following:
        a. Contractor shall pay associated costs for the Engineer to evaluate the substitution.
        b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
        c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
        d. Proposed substitution is equal or superior to the specified product.
        e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless Owner requires a Special Warranty.
        f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
        g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

1.04 SUBMITTAL IDENTIFICATION NUMBERING

A. Number each Submittal using the format defined in the table below:

	Spec Section Number	Dash	Initial Submittal - Sequential Number	Decimal Point	Subsequent Submittal Revisions Sequential Number
Example 1 Description	*Cast-In-Place Concrete*		*8th initial Submittal*		
	03300	-	0008		
Example 2 Description	*Cast-In-Place Concrete*		*8th initial Submittal*		*First revision to the 8th initial Submittal*
	03300	-	0008	.	1

1.05 SUBMITTALS IN ELECTRONIC MEDIA FORMAT

A. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.

B. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).

C. Graphics: Provide graphic Submittals (Drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.06 SUBMITTAL PROCEDURE

A. Engineer: Review Submittal and provide response:
   1. Review description:
      a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular Submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
      b. Engineer's review of Submittals shall not release the Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall the Engineer's review release the Contractor from fulfilling purpose of installation nor from the Contractor's liability to replace defective work.
      c. Engineer's review of Shop Drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
      d. Engineer's review does not extend to:
         1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by the Contractor.
         2) Contractor's means, methods, techniques, sequences, or procedures, except when specified, indicated on the Drawings, or required by Contract Documents.

3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.

e. Engineer can Approve or Not Approve any exception at their sole discretion.

2. Review timeframe:
   a. Except as may be provided in technical Specifications, a Submittal will be returned within 30 days.
   b. When a Submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the Submittal, give notice of the date by which that Submittal will be returned.
   c. Engineer's acceptance of progress schedule containing Submittal review times less than those specified or agreed to in writing by the Engineer will not constitute Engineer's acceptance of review times.
   d. Critical Submittals:
      1) Contractor will notify Engineer in writing that timely review of a Submittal is critical to the progress of Work.
3. Schedule delays:
   a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of Submittals unless all of the following criteria are met:
      1) Engineer has failed to review and return first submission within the agreed upon time frame.
      2) Contractor demonstrates that delay in progress of Work is directly attributable to Engineer's failure to return Submittal within time indicated and accepted by Engineer.
4. Review response will be returned to the Contractor with one of the following dispositions:
   a. Approved:
      1) No Exceptions:
         a) There are no notations or comments on the Submittal and the Contractor may release the equipment for production.
      2) Make Corrections Noted - See Comments:
         a) The Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Resubmittal not required.
      3) Make Corrections Noted - Confirm:
         a) The Contractor may proceed with the Work, however, all notations and comments must be incorporated into the final product.
         b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.
   b. Not Approved:
      1) Correct and Resubmit:
         a) Contractor may not proceed with the Work described in the Submittal.
         b) Contractor assumes responsibility for proceeding without approval.
         c) Resubmittal of complete Submittal package is required within 30 calendar days of the date of the Engineer's Submittal review response.

2) Rejected - See Remarks:
a) Contractor may not proceed with the Work described in the Submittal.
b) The Submittal does not meet the intent of the Contract Documents. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

c. Receipt Acknowledged:
1) Filed for Record:
a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.
2) With Comments - Resubmit:
a) This is used in acknowledging receipt of informational Submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc. Feedback regarding missing information, conflicting information, or other information that makes it incomplete can be made with comments.

B. Contractor: Prepare resubmittal, if applicable:
1. Clearly identify each correction or change made.
2. Include a response in writing to each of the Engineer's comments or questions for Submittal packages that are resubmitted in the order that the comments or questions were presented from the first and subsequent Submittals and numbered consistent with the Engineer's numbering.
a. Acceptable responses to Engineer's comments are listed below:
1) "Incorporated" - Engineer's comment or change is accepted and appropriate changes are made.
2) "Response" - Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by the Engineer.
b. Reviews and resubmittals:
1) Contractor shall provide resubmittals which include responses to all Submittal review comments separately and at a level of detail commensurate with each comment.
2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment
a) Responses such as "acknowledged" or "noted" are not acceptable.
3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant Submittals.
5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.

c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for revision and resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Resubmittal timeframe:
   a. Contractor shall provide resubmittal within 15 days.
   b. When a resubmittal cannot be returned within the specified period, Contractor shall notify the Engineer in writing.
4. Review costs:
   a. Costs incurred by the Owner as a result of additional reviews of a particular Submittal after the second time it has been reviewed shall be borne by the Contractor.
   b. Reimbursement to the Owner will be made by deducting such costs from the Contractor's subsequent progress payments.

1.07 PRODUCT DATA

A. Edit Submittals so that the Submittal specifically applies to only the product furnished.

B. Neatly cross out all extraneous text, options, models, etc., that do not apply to the product being furnished so that the information remaining is only applicable to the product being furnished.

1.08 SHOP DRAWINGS

A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of Shop Drawings.

B. Indicate Project-designated equipment tag numbers for Submittal of devices, equipment, and assemblies.

1.09 SAMPLES

A. Details:
   1. Submit labeled samples.
   2. Samples will not be returned.
   3. Provide number of sample Submittals as below:
      a. Total: 2 minimum.
         1) Owner: 1.
         2) Engineer: 1.
         3) Contractor: None.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - CONTRACTOR SUBMITTAL TRANSMITTAL FORM

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY
Contractor:	Click here to enter text.	**Project No.:**	XXXXX.XX
Project Name:	Click here to enter text.	**Submittal Number:**	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal/Equipment Supplier			
Spec ##:	Spec ##.	**Subject:**	Click here to enter text.
Authored By:	Click here to enter text.	**Date Submitted:**	XX/XX/XXXX

Submittal Certification	
Check Either (A) or (B):	
☐	(A) We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings with no exceptions.
☐	(B) We have verified that the equipment or material contained in this Submittal meets all the requirements specified in the project manual or shown on the Contract Drawings, except for the deviations listed.
Certification Statement: By this Submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved Shop Drawings and all Contract requirements.	
General Contractor's Reviewer's Signature:	
Printed Name:	
In the event Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.	
Firm: Click here to enter text.	**Signature:** **Date Returned:** XX/XX/XXXX

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

SECTION 01354

HAZARDOUS MATERIAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Procedures required when encountering hazardous materials at the Work site.

1.02 REFERENCES

A. Occupational Safety and Health Administration (OSHA).

B. United States Code of Federal Regulation (CFR):
   1. Title 29 - Labor:
      a. 1926.62 - Lead.
   2. Title 40 - Protection of Environment:
      a. 261 - Identification and Listing of Hazardous Waste.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Adequately wet: Penetration of the pipe wall with liquid to prevent release of particulates.
   2. Asbestos cement pipe: Also commonly referred to as AC transite pipe, AC pipe or ACP. Pipe that is generally composed of cement and asbestos fibers.
   3. Competent person: A trained worker who is capable of identifying existing and predictable asbestos hazards, perform exposure assessment and monitoring, is qualified to train other workers, and has the authority to take immediate corrective action to eliminate a hazardous exposure.
   4. Non-friable asbestos-containing material (NACM): Material containing more than 1 percent asbestos, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
   5. Regulated asbestos-containing material (RACM): Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder in the course of work.

1.04 SUBMITTALS

A. Submit laboratory reports, hazardous material removal plans, and certifications.

B. At a minimum, submit the following work plans:
   1. Removal and Legal Disposal of Lead Based Paint Pipe Plan.
      a. Work plan shall include, but not be limited, to the following:
         1) Schedule of work.
         2) Security measures for work and disposal area.

3) Staff training: Provide at least one competent person who is capable of identifying lead based paint hazards at the job site for the entire duration of the lead based paint removal and disposal operation.

2. Removal and Legal Disposal of Asbestos Cement Pipe Plan.
   a. Work plan shall include, but not be limited, to the following:
      1) Schedule of work.
      2) Security measures for work and disposal area.
      3) Staff training: Provide at least one competent person who is capable of identifying asbestos hazards at the job site for the entire duration of the AC pipe removal and disposal operation.
      4) Trenching and removal of pipe procedure.

1.05 HAZARDOUS MATERIALS SURVEY

A. The Owner has provided a Hazardous Materials Inspection report (Terracon, January 2025) for the Contractors use, as an attachment to the Contract documents.

B. This report is not a bidding document. Contractors or consultants reviewing this report must draw their own conclusions regarding further investigation or remediation deemed necessary.

C. Provision of this document does not preclude the Contractor from conducting their own hazardous materials investigations and properly following all hazardous materials procedures as defined herein, and per state and federal codes.

1.06 HAZARDOUS MATERIALS PROCEDURES

A. Hazardous materials are those defined by 40 CFR and State specific codes.

B. When hazardous materials have been found that were identified by survey:
   1. Prepare and initiate implementation of plan of action.
   2. Notify such agencies as are required to be notified by laws and regulations within the times stipulated by such laws and regulations.
   3. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.
   4. Identify and contact Subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

C. Forward to Engineer, copies of reports, permits, receipts, and other documentation related to remedial work.

D. Assume responsibility for worker health and safety, including health and safety of Subcontractors and their workers.
   1. Instruct workers on recognition and reporting of materials that may be hazardous.

E. File requests for adjustments to Contract Times and Contract Price due to the finding of Hazardous Materials in the Work site in accordance with Contract Documents.
   1. Minimize delays by continuing performance of the Work in areas not affected by hazardous materials operations.

F. When other hazardous materials have been found:
   1. Prepare and initiate implementation of plan of action.
   2. Notify immediately Owner, Engineer, and other affected persons.
   3. Notify such agencies as are required to be notified by laws and regulations with the times stipulated by such laws and regulations.
   4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.
   5. Identify and contact Subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

1.07 LEAD PAINT REMOVAL AND DISPOSAL

A. Existing paint on the interior and exterior surfaces that may contain lead in concentrations which will require implementation of hazardous material compliance procedures as legislated by the following:
   1. CFR, Title 29 and Title 40.

B. Remove samples of paint from the structures identified in this Section and have samples tested by a certified testing laboratory to determine lead content in samples.
   1. Ensure that sufficient numbers of paint samples are removed and tested to provide adequate information regarding lead content in paint.
   2. Ensure that samples contain the total thickness of the paint to the substrate where removed.
   3. Ensure that each sample contains a sufficient quantity of paint to facilitate proper and adequate analyses by testing laboratory.
   4. Ensure that samples are adequately identified with location from which they were removed.

C. Laboratory testing of paint samples: In accordance with 40 CFR 261,
   1. Submit complete laboratory analyses of paint samples.

D. Submit a plan for the removal, containment, and disposal of lead-based paint and associated debris.

E. Prior to beginning work associated with the removal, containment, and disposal of lead-based paints, prepare and submit to the Engineer for his review 3 copies of the following:
   1. Listing of lead paint removal equipment to be used.
   2. Outline of procedures to be used to remove lead paint.
   3. Data and specifications describing chemical stripping materials to be used.
   4. Data and specifications describing abrasive blast materials and grit size to be used.
   5. Plan describing lead paint removal, hazardous waste debris containment, and hazardous waste disposal methods.

6. Safety plan, consisting of a written plan of action covering operational requirements for safe removal of lead paint, safe handling and containment of waste and debris generated by the operation, and safe disposal of hazardous waste and non-hazardous waste materials, complying with the most stringent requirements of the following:
    a. Equipment and material manufacturer's safety sheets.
    b. 29 CFR 1926.62.

F. Carry out lead paint removal, containment, and disposal work in accordance with the following SSPC guidelines:
    1. SSPC-Guide 6.
        a. Open Abrasive Blast Cleaning with Expendable Abrasive.
        b. Open Abrasive Blast Cleaning with Recyclable Abrasive.
        c. Closed Abrasive Blast Cleaning with Recyclable Abrasive.
        d. Chemical Stripping.
    2. SSPC-Guide 7.

G. Assume responsibility for the proper utilization of the paint removal method selected.
    1. When abrasive blast cleaning is selected to remove lead-based paint, comply with all applicable federal, state, and local air quality, pollution, and environmental control regulations for blast cleaning.
    2. When chemical stripping is selected to remove the lead based paint, adhere to the chemical manufacturer's recommendations for the application of the product, the removal of the paint, and the containment of the debris.

H. Lead paint removal work shall be performed by a Contractor having prior experience in the removal method selected and shall provide at least 5 references of similar projects completed, 3 of which must have been completed within the past 12 months, documenting his experience.

I. Utilize a minimum of Class 3 containment and ventilation system as described in SSPC-Guide 6 during lead paint removal and containment procedures as required for the conditions.

J. Do not leave spent abrasive blast material, chemical stripping material, or lead paint debris uncontained on the project site overnight.

K. Test each container of paint debris, spent blast cleaning abrasive, chemical stripping debris, and other waste material generated by the operation to determine the waste material hazardous waste classification.

L. Test each stripped surface to confirm residual lead levels below OSHA action level prior to re-coating.

M. Assume responsibility for the disposal of lead paint waste and associated waste generated by the removal of the lead paint and the preparation of the surfaces for recoating. Dispose in accordance with applicable federal, state, and local requirements and regulations.

N. Accurately complete the Uniform Hazardous Waste Manifest included at the end of SSPC-Guide 7. Indicate on the Manifest that the Owner is the hazardous waste

generator, and obtain the Owner's Environmental Protection Agency identification number for use in completing the Manifest.

1.08 ASBESTOS MATERIALS

A. It is the specific intent of these Contract Documents to exclude from the Work any and all products or materials containing asbestos. No products containing asbestos shall be incorporated in the Work.

B. Asbestos has been identified by Owner in paint, gaskets, and some piping used on site. Contractor shall test these and other materials encountered (including pipe and wire insulation).

C. Removal of existing ACM shall be performed by a firm that is registered by OSHA and certified by the State Contractors Licensing Board and shall be a licensed abatement contractor in the state where the Project is located.

D. Submit plan for the removal, containment, and disposal of ACM.

E. Submit abatement license of ACM removal contractor.

PART 2 PRODUCTS

2.01 ASBESTOS PIPE

A. Asbestos pipe identified in the underdrain of Filters 1-6 shall not be disturbed.
   1. Manufacturer and exact composition of the pipe to be encountered is unknown.

PART 3 EXECUTION

3.01 ASBESTOS MATERIALS

A. Notifications:
   1. Notify OSHA 24 hours prior to performing asbestos material removal operations.
   2. Notify Owner 3 working days in advance of commencing asbestos material removal operations.

B. Work area:
   1. Establish a regulated work area, using at a minimum, construction warning tape to establish limits of work area for the asbestos material removal.
   2. On site stockpiling or storage of asbestos material designated for disposal shall not be allowed.

C. Safety:
   1. Conduct an Initial Exposure Assessment (IEA).
   2. Provide a hand/face wash station.

D. Worker qualifications:
   1. Asbestos removal shall be performed by employees trained in wet methods, vacuum cleaners with HEPA filters to collect debris and prompt cleanup.

E. Legal disposal:
   1. Legal disposal of asbestos material is the Owner's responsibility.
   2. Transport the asbestos material to the location identified by the Contractor and approved by the Owner at and place into the location designated for this project.

3.02 EXCAVATION OF AC PIPE (IF REQUIRED)

A. Machine excavate to expose asbestos cement pipe.

B. Hand excavate areas under pipe where breaks are planned.

C. Pipe shall be pre-wetted prior to any breaks being made.

D. Pipe shall be snapped using mechanical snapping methods.

3.03 AC PIPE REMOVAL (IF REQUIRED)

A. All required pipe breaking operations shall require adequate pre-wetting with potable water.

B. Make every effort to minimize the number of pipe breaks. Wherever possible, the pipe should be removed by pulling the pipe out of the pipe joint collars.

C. Remove sections of AC pipe intact at joint collars by mechanical snapping methods between collars.

D. Wet and containerize waste materials as removed from the trench. Use lifting straps and methods that do not further damage the pipe.

E. Sections of AC pipe that become cut, have broken edges or have any friable surface shall be wet at exposed fractures and immediately wrapped.
   1. Pipe ends shall be sealed completely using a minimum 6-mil poly film wrap, which is securely fastened, taped to completely enclose the pipe and ACP appurtenances and shall have conspicuous, legible labeling that has the following or equivalent labeling: CAUTION: CONTAINS ASBESTOS FIBERS. BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM.

F. AC pipe sections shall not be left exposed in public view, either in trench or in disposal area.

G. All connecting parts of pipe, rubber gaskets, and pipe couplings shall be discarded with pipe.

H. AC pipe from this project only shall be placed in the bin designated (to be provided by Owner).

3.04 LEAD BASED PAINT REMOVAL

A. All lead based paint identified in the attached Hazardous Materials Inspection as well as locations indicated on the Drawings shall be removed in accordance with the procedures indicated herein.

B. Where lead based paint has been removed, Contractor shall recoat with the coating systems and requirements defined in section 09960 - High Performance Coatings.

END OF SECTION

SECTION 01355

STORMWATER POLLUTION PREVENTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for preparation and implementation of the Stormwater Pollution Prevention Plan (SWPPP) for the Contractor's construction activities for the purposes of applying and obtaining a State of Utah Storm Water General Permit for Construction Activities (Permit). This Permit authorizes storm water discharges to waters of the State of Utah resulting from construction activities, including construction support activities, anywhere within the State of Utah. Contractor shall also be responsible for applying for and obtaining any local SWPPP permits that may be required.

1.02 REFERENCES

A. National Pollutant Discharge Elimination System (NPDES).

B. State of Utah Department of Environmental Quality, Division of Water Quality.

C. United States Code of Federal Regulation (CFR):
   1. Title 40 - Environmental Protection Agency:
      a. Part 117 - Determination of reportable quantities for hazardous substance.
      b. Part 302 - Designation, reportable quantities, and notification.

1.03 SUBMITTALS

A. Stormwater Pollution Prevention Plan:
   1. Prepare and submit a Stormwater Pollution Prevention Plan (SWPPP) in accordance with Part IV of the General Permit for Discharge from Construction Activities to the Owner for reference.
   2. The SWPPP must detail which measures will be used for (1) Stormwater Controls; (2) Erosion and Sedimentation Controls; (3) Good Housekeeping; (4) Stabilization Practices; and (5) Structural Practices.
   3. Submit to the Owner for reference, a plan detailing the placement of physical controls, such as Best Management Practices (BMPs), required for installation and the methods used to comply with those controls.
   4. The plan shall specifically address and detail the Contractor’s preferred techniques and shall show how they will comply with the stated objectives of the General Permit.

B. The entire plan shall be kept and maintained by the Contractor on the construction site during the duration of the project.

C. The Contractor shall be responsible for taking the proper actions to prevent contaminants and sediments from entering the storm sewer drainage system should any unforeseen circumstance occur. The Contractor shall take immediate action if directed by the Engineer, or if the Contractor observes contaminants and/or sediments entering the storm drainage system, to prevent further stormwater from entering the system.

1.04 REGULATORY REQUIREMENTS

A. The Contractor shall comply with the State of Utah Department of Environmental Quality, Division of Water Quality, county, city, and other local agency requirements regarding stormwater discharges and management.

B. The Contractor shall not begin any construction work until the Contractor has secured the permit.

C. The Contractor shall comply with the following prohibitions and limitations, which are contained in the Stormwater Permit.
   1. Discharge prohibitions:
      a. Discharges of materials other than stormwater, which are not otherwise regulated by a NPDES permit, to a separate stormwater sewer system or water of the nation are prohibited.
      b. Stormwater discharges shall not cause or threaten to cause pollution, contamination (including sediment), or nuisance.
      c. Stormwater discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR Part 117 and 40 CFR Part 302.
   2. Receiving water limitations:
      a. Stormwater discharges to any surface or groundwater shall not adversely impact human health or the environment.
      b. Stormwater discharge shall not cause or contribute to a violation of any applicable water quality standards.

D. Requirements.
   1. In order to comply with the permit mandates, a national model has been prepared for use by those preparing a storm water pollution prevention plan. It is recommended that the Contractor use the model template or review the elements of the template to ensure that the plan is prepared in compliance with the State permit.
   2. BMPs are measures or practices used to reduce the amount of pollution entering surface water. BMPs may take the form of a process, activity, or physical structure. Some BMPs are simple and can be put into place immediately, while others are more complicated and require extensive planning or space. They may be inexpensive or costly to implement. No additional compensation shall be made for implementation of BMPs.

1.05 STORMWATER POLLUTION PREVENTION PLAN IMPLEMENTATION

A. The Contractor shall implement all activities required by the General Permit and as detailed in the Stormwater Pollution Prevention Plan.

1.06 NON-STORMWATER MANAGEMENT

A. The Stormwater Pollution Prevention Plan shall discuss any non-storm water sources (i.e., lake water, landscaping irrigation, pipe flushing, street washing, and dewatering). In addition, the Plan shall include standard observation measures and best management practices, including best available technologies economically achievable, and best conventional pollutant control technologies that are to be implemented in order to reduce the pollutant loading to the waters.

1.07 AMENDMENTS

A. The Contractor shall amend the Stormwater Pollution Prevention Plan whenever there is a change in construction or operations which may affect the discharge of pollutants to stormwater.

B. The Stormwater Pollution Prevention Plan shall also be amended if it is in violation of any conditions of the general permit or has not achieved the general objective of reducing pollutants in stormwater discharges.

C. All amendments shall be completed at no additional cost to the Owner.

1.08 ANNUAL SUMMARY

A. The Contractor shall submit any annual summary reports that may be required for the Permit.

1.09 NOTICE OF TERMINATION

A. The Contractor shall any termination or completion notices that may be required by the Permit.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01357

DELEGATED DESIGN PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Delegated Design procedures.

1.02 GENERAL

A. Delegated Design - Professional design services assigned to the Contractor by express delegation in the Contract Documents. Work is “Delegated Design” where the Technical Sections require the Contractor to provide professional design services and to submit signed and sealed documents from a registered Professional Engineer.

B. Contractor’s Professional Engineer - The design professional retained by the Contractor to perform Delegated Design.

C. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents.
   1. Requirements of Delegated Design component as specified in the Technical Section and as indicated on the Drawings.
   2. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that the Contractor must furnish to the Engineer with respect to the Delegated Design.

D. Contractor shall cause such Delegated Design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal shall appear on Drawings, calculations, Specifications, certifications, and Submittals prepared by such design professional.
   1. Contractor shall not be responsible for the adequacy of performance or design criteria specified by the Owner or Engineer.
   2. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.
   3. Such design professional shall issue certifications of design required by Laws and Regulations.
   4. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by the Contractor, a Subcontractor, or others for submittal to the Engineer, then such Shop Drawing or other Submittal shall bear the written approval of Contractor’s design professional when submitted by the Contractor to the Engineer.

E. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under Delegated

Design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

F. Engineer's review, approval, and other determinations regarding design drawings, calculations, Specifications, certifications, and other Submittals furnished by Contractor pursuant to a Delegated Design will be only for the following limited purposes:
   1. Confirming that Submittal is in conformance with the performance and design criteria specified in the Contract Documents.

1.03 CONTRACTOR'S PROFESSIONAL ENGINEER

A. Contractor or Subcontractor shall retain a licensed Professional Engineer to perform Delegated Design.

B. Qualifications:
   1. Holding a current license to perform the specified design in the same jurisdiction as the Project site.
   2. Experienced in designing similar systems of similar complexity.

C. Insurance:
   1. Provide Contractor's Professional Engineer's Professional Liability Insurance as specified –Supplemental General Conditions.

D. Responsibilities:
   1. Review and design in accordance with system performance and design criteria stated in the Contract Documents.
      a. Prepare written requests for clarifications or interpretations of performance or design criteria for submittal to the Engineer by the Contractor.
   2. Sign and seal design reports, calculations, design drawings and specifications, and other design Submittals for the Delegated Design Work.
   3. Review and submit written approval of Submittals related to the Delegated Design Work.
   4. Design modifications to the Delegated Design Work as required.
   5. Visit the Site, as required, to verify that installation of the Delegated Design Work is in conformance with the Delegated Design Drawings and Specifications.
   6. Submit through Contractor to Engineer written, signed, and sealed certification that the installed Delegated Design Work complies with Contractor's Professional Engineer's design.

1.04 SUBMITTALS

A. Prior to the start of Delegated Design:
   1. Contractor's Professional Engineer's qualifications:
      a. Experience in performing services for the Delegated Design.
      b. Evidence of actively performing services of Professional Engineering.
   2. Contractor's Professional Engineer Professional Liability Insurance certificate.

B. Delegated Design:
    1. Product data:
        a. Details related to the Delegated Design as specified in Technical Sections to completely describe the system.
    2. Design documents with signature and seal from the Contractor's Professional Engineer. The professional seal must be issued by the state of Utah.
        a. Design documents include but are not limited to Drawings, calculations, Specifications, inspection reports, and certifications.
    3. Lists and schedules:
        a. Prepare and submit lists or schedules of items where Delegated Design is required by the Contract Documents.
        b. Group items by location in the Work.
            1) When "Area Numbers" are indicated on the Contract Drawings, group lists in accordance with those "areas."
            2) For work without area numbers, group using logical divisions acceptable to the Engineer.
            3) Group items within each "area" as follows:
                a) Systems.
                b) Components.
                c) Supports.
                d) Anchorage.
                e) Bracing.

C. Construction services:
    1. Contractor's Professional Engineer's comments on Submittals.
    2. Other construction documents, as required.

1.05 ENGINEER RESPONSE TO DELEGATED DESIGN SUBMITTALS

A. Engineer response will be either of the following:
    1. Approved. Make Corrections Noted - See Comments:
        a. Contractor may proceed with the Work; however, all notations and comments must be incorporated into the final product.
        b. Review was for the limited purpose of determining that the document was stamped by a Professional Engineer and that such design is generally consistent with and will not negatively affect the design concept presented in the Contract Documents.
    2. Rejected - See Remarks:
        a. Contractor may not proceed with the Work described in the Submittal.
        b. Submittal does not meet the intent of the Contract Documents.
        c. Resubmittal of complete Submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Regulatory authorities and codes.

1.02 AUTHORITIES HAVING JURISDICTION (AHJ)

A. Also referred to as the permitting agency.

B. Building Department: Herriman City.

C. Fire Department: Unified Fire Authority.

D. Utah Department of Environmental Quality, Division of Drinking Water.

1.03 APPLICABLE CODES

A. International Code Council (ICC).
   1. Building code:
      a. International Building Code (IBC), 2021.
         1) Applicable Utah State Amendments.
         2) Design Criteria additions per Herriman City Building Code and Design Criteria.
      b. International Existing Building Code (IEBC), 2021.
         1) Local amendments.
   2. Electrical code:
      a. National Fire Protection Association (NFPA), NFPA 70: National Electrical Code (NEC), 2020.
         1) Applicable Utah State and Local amendments.
   3. Energy code:
      a. International Energy Conservation Code (IECC), 2021.
         1) Applicable Utah State and Local amendments.
   4. Fire code:
      a. International Fire Code (IFC), 2021.
         1) Applicable Utah State and Local amendments.
   5. Fuel gas code:
      a. International Fuel Gas Code (IFGC), 2021.
         1) Applicable Utah State and Local amendments.
   6. Mechanical code:
      a. International Mechanical Code (IMC), 2021.
         1) Applicable Utah State and Local amendments.
   7. Plumbing code:
      a. International Plumbing Code (IPC), 2021.
         1) Applicable Utah State and Local amendments.

B. Products in contact with drinking water
   1. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.
      a. Certification by an independent ANSI accredited third party, including, but not limited to, NSF International, as being lead free.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Quality control and control of installation.
   2. Tolerances.
   3. References.
   4. Mock-up requirements.
   5. Authority and duties of Owner's representative or inspector.
   6. Sampling and testing.
   7. Testing and inspection services.
   8. Contractor's responsibilities.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. When specified, products will be tested and inspected either at point of origin or at Work site:
   1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

B. National Institute of Standards and Technology (NIST).

1.05 PRODUCT REQUIREMENTS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

C. Obtain copies of standards where required by product specification sections.

D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.06 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.07 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner’s Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.

E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.08 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
   4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.09 TESTING AND INSPECTION SERVICES

A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.

B. Owner/Engineer will employ and pay for specified services of an “Owner’s independent testing firm” certified to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01455 - Regulatory Quality Assurance to confirm Contractor’s compliance with Contract Documents.

C. The Owner/Engineer’s independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.

D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets “Recommended Requirements for Independent Laboratory Qualification,” published by American Council of Independent Laboratories.
   3. Meets requirements of ASTM E329.
   4. Laboratory Staff: Maintain full time specialist on staff to review services.
   5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to NIST or accepted values of natural physical constants.
   6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NIST during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

E. Testing, inspections, and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

F. Contractor shall cooperate with Owner/Engineer’s independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify Engineer and Owner/Engineer’s independent testing firm 48 hours prior to expected time for operations requiring testing.
   2. Make arrangements with Owner/Engineer’s independent testing firm and pay for additional samples and tests required for Contractor’s use.

G. Limitations of authority of testing Laboratory: Owner’s independent testing firm or Laboratory is not authorized to:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency or laboratory may not approve or accept any portion of the Work.
   3. Agency or laboratory may not assume duties of Contractor.
   4. Agency or laboratory has no authority to stop the Work.

H. Testing and employment of an Owner/Engineer’s independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner/Engineer’s independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

J. The Owner/Engineer's independent testing firm responsibilities will include:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Engineer.
   7. Attend preconstruction meetings and progress meetings when requested.

K. Owner/Engineer's independent testing firm individual test reports:
   1. After each test, Owner's independent testing firm will promptly submit electronically report to Engineer and to Contractor.
   2. Test reports shall include at least the following information:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in Project.
      g. Type of inspection or test.
      h. Date of test.
      i. Certified test results stamped and signed by a registered Engineer in the state where the project is located.
      j. Summary of conformance with Contract Documents.
      k. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results.

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.

B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Submit product test reports electronically.

E. Furnish incidental labor and facilities:
   1. To provide access to construction to be tested.
   2. To obtain and handle samples at Work site or at source of product to be tested.
   3. To facilitate inspections and tests.

4. For storage and curing of test samples.

F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01455

REGULATORY QUALITY ASSURANCE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Project regulatory requirements for quality assurance that includes Special Inspections, Special Certification, and Structural Observation.

B. Special Certifications, Special Inspections, and Special Observations of structural assemblies and components to be performed in compliance with the building code specified in Section 01410 - Regulatory Requirements.

C. Special Certification and Special Inspections in this Section are in addition to the requirements specified in Section 01450 - Quality Control, and in the individual Sections.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete.
   2. 530 - Building Code Requirements for Masonry Structures.
   3. 530.1 - Specification for Masonry Structures.

B. American Institute of Steel Construction (AISC):
   1. 360 - Specification for Structural Steel Buildings.

C. American Society of Civil Engineers (ASCE):
   1. 7 - Minimum Design Loads for Buildings and Other Structures.

D. American Welding Society (AWS):
   1. D1.3 - Structural Welding Code - Sheet Steel.
   2. D1.4 - Structural Welding Code - Reinforcing Steel.

E. ASTM International (ASTM):
   1. A706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
   2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
   4. C1611 - Standard Test Method for Slump Flow of Self-Consolidating Concrete.

F. Building Code:
   1. International Building Code (IBC) as specified in Section 01410 - Regulatory Requirements.

G. The Masonry Society (TMS):
   1. 402 - Building Code for Masonry Structures.
   2. 602 - Specifications for Masonry Structures.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Special Certification: Certification for designated seismic systems that demonstrates compliance with performance requirements.
   2. Special Inspection: Inspection of the materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.
   3. Special Inspection, Continuous: The full-time observation of work requiring Special Inspection by an approved special inspector who is present in the area where the work is being performed.
   4. Special Inspection, Periodic: The part-time, or intermittent observation of work requiring Special Inspection by an approved special inspector who is present in the area where the work is being performed and at the completion of the work.
   5. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant construction stages and at completion of the structural system. Structural observation does not include or waive the responsibility for special inspections.

1.04 SUBMITTALS

A. Submit Special Certifications for designated seismic systems.

B. Schedule and coordinate the submittal of Special Inspection reports and test results prepared by others.

1.05 SPECIAL INSPECTION

A. Owner will employ one or more special inspectors who will provide Special Inspections during construction.

B. Special inspector(s) shall be qualified for inspection of the particular type of materials or operations requiring Special Inspection.

C. Testing laboratory: Testing that is required to satisfy the requirements of Special Inspection will be performed by the Owner’s testing laboratory as specified in Section 01450 - Quality Control.

D. Duties of special inspector:
   1. General: Required duties of the special inspector(s) shall be as described in the Building Code.

2. Reporting: Special inspector(s) shall provide reports of each inspection to the Owner and shall distribute copies of inspection reports to the Engineer and Contractor as required.
    a. Reports shall, at a minimum, include the following items:
        1) Date and time of inspection, and name(s) of individual(s) performing the inspection.
        2) Structures and areas of the structure where work or testing was observed.
        3) Discrepancies between the requirements of the Contract Documents and the work or testing observed.
        4) Other areas of deficiency in the Work.

E. Special Inspections shall not be construed as fulfilling the requirements for Structural Observation.

F. Owner or special inspector are responsible to select materials for Special Inspection.
    1. Contractor shall not select materials for Special Inspection.

1.06 TESTING

A. Testing laboratory: Special tests will be performed by Owner's testing laboratory as specified in Section 01450 - Quality Control.

B. Selection of the material to be tested shall be by the Engineer or by Owner's testing laboratory, and not the Contractor.

1.07 SPECIAL CERTIFICATION

A. Provide equipment that meets the special certification requirements of the regulatory building code.

B. Designated seismic systems shall be subject to the testing and qualification requirements of the regulatory Building Code, and shall require Special Certification as set forth in ASCE 7 and shall require Special Certification as set forth in ASCE 7, Section 13.2:
    1. Mechanical equipment that is assigned an importance factor of 1.50 as specified in Section 01850 - Design Criteria.
    2. All electrical equipment.

C. Special certification requirements for designated seismic systems:
    1. Submittals shall include certification that the equipment is seismically qualified. Certifications are subject to review and acceptance by Owner.
    2. Certifications may be at least one of the following in accordance with ASCE 7:
        a. Analysis.
        b. Testing.
        c. Experience data.

1.08 STRUCTURAL OBSERVATION

A. Owner will employ one or more registered design professionals to provide Structural Observation(s) during construction.
    1. Registered design professional will be a civil or structural engineer currently licensed as such in the state where the project is located and regularly

engaged in structural design equivalent to or similar to that indicated on the Drawings.

B. Structural Observations shall not be construed as fulfilling the requirements for Special Inspections.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SPECIAL INSPECTIONS

A. Owner will provide Special Inspection of the following types of work as described in the Building Code wherever such work occurs, unless otherwise specified.
   1. Attachment A - Concrete - Special Inspection Schedule.
   2. Attachment B - Architectural, Mechanical, and Electrical Components - Special Inspection Schedule.
   3. Attachment C2 - Masonry Special Inspection Schedule - “Level C".
   4. Attachment D - Soils - Special Inspection Schedule.
   5. Attachment E - Structural Steel Welding - Special Inspection Schedule.
   6. Attachment F - Structural Steel Bolting - Special Inspection Schedule.
   7. Attachment G - Steel Construction - Steel Deck, Open Web Steel Joists and Joist Girders, and Cold Formed Steel Trusses - Special Inspection Schedule.

3.02 SPECIAL CERTIFICATION

A. Special inspector shall examine the designated seismic system(s) and determine whether the designated system components, including anchorage, are consistent with the evidence of compliance submitted for Special Certification.

3.03 STRUCTURAL OBSERVATION

A. The following work requires Structural Observation in accordance with the Building Code.
   1. All structures in all areas:
      a. Foundation reinforcement.
      b. Elevated slab reinforcement.
      c. New foundation dowels into existing foundation.
      d. CMU wall reinforcement prior to the first grout lift placement.
      e. CMU wall reinforcement prior to grout lift placement at diaphragms.
      f. Roof diaphragm to wall connections and metal deck fastening.
      g. First 10 adhesive epoxy dowels installation on existing structures.

3.04 OTHER SPECIFIC TESTS

A. Other unusual materials that are expected to support design live loads.

3.05 SCHEDULE

A. Allow time necessary for Special Inspections and Structural Observation specified in this Section.

B. Sufficient notice shall be given so that the Special Inspections and Structural Observations can be performed. Allow time for individuals performing to travel to the site.

3.06 PROCEDURE

A. Special inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.

B. Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

ATTACHMENT A - CONCRETE - SPECIAL INSPECTION SCHEDULE

CONCRETE - SPECIAL INSPECTION SCHEDULE
(Includes: Cast-in-place, precast, prestressed, precast-prestressed, and shotcrete.)

Verification and Inspection	Reference Standard	Frequency of Inspection[(1)] (During Task Listed)	
		Continuous	Periodic
1. Inspect reinforcement, including prestressing tendons, and verify placement.	ACI 318/ Building Code		●
2. Reinforcing bar welding:			
a. Verify weldability of reinforcing bars other than ASTM A706;	AWS D1.4/ ACI 318		●
b. Inspect single-pass fillet welds, maximum 5/16 inch; and	AWS D1.4 ACI 318		●
c. Inspect all other welds.	AWS D1.4 ACI 318	●	
3. Inspect anchors cast in concrete.	ACI 318		●
4. Inspect anchors post-installed in hardened concrete members:			
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads.	ACI 318	●	
b. Mechanical anchors and adhesive anchors not defined in 4.a.	ACI 318		●
5. Verify use of required design mix.	ACI 318/ Building Code		●
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172/ ASTM C31/ ACI 318	●	
7. Inspect concrete and shotcrete placement for proper application techniques.	ACI 318	●	
8. Verify maintenance of specified curing temperature and techniques.	ACI 318		●
9. Inspect prestressed concrete for:			
a. Application of prestressing forces; and	ACI 318	●	
b. Grouting of bonded prestressing tendons.	ACI 318	●	
10. Inspect erection of precast concrete members.	ACI 318		●
11. For precast concrete diaphragm connections or reinforcement at joints as moderate or high deformability elements in structures assigned to Seismic Design Category C, D, E or F. Inspect such connections and reinforcement in the field for:			

Verification and Inspection	Reference Standard	Frequency of Inspection[(1)] (During Task Listed)	
		Continuous	Periodic
a. Installation of the embedded parts.	ACI 318	●	
b. Completion of the continuity of the reinforcement across joints.	ACI 318	●	
c. Completion of connections in the field.	ACI 318	●	
12. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5.	ACI 318		●
13. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	ACI 318		●
14. Inspect formwork for shape, location and dimensions of the concrete member being formed.	ACI 318		●
Notes: (1) "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT B - ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

ARCHITECTURAL, MECHANICAL, AND ELECTRICAL COMPONENTS - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Architectural components:			
a. Cladding - exterior, weighing more than 5 psf: Erection and fastening.	Building Code		●
b. Exterior insulation and finish system (EIFS):	Building Code		
c. Non-bearing walls - exterior: Erection and fastening.	Building Code		●
d. Non-bearing walls - interior, weighing more than 15 psf.	Building Code		●
e. Veneer, exterior and interior, weighing more than 5 psf: Erection and fastening.	Building Code		●
f. Access floors: Erection and anchorage.	Building Code		●
g. Suspended ceiling system: Bracing.			●
h. Storage racks - 8 feet or greater in height: Anchorage.	Building Code		●
i. Skylight: Verification of safety compliance and labeling and installation.	Building Code		●
2. Plumbing, mechanical, and electrical components:			
a. Anchorage of electrical equipment for emergency and standby power systems.	Building Code		●
b. Anchorage of other electrical and mechanical equipment over 400 lb. on floors or roofs.	Building Code		●
c. Installation and anchorage of pipelines carrying hazardous chemicals and their associated mechanical units.	Building Code		●
d. Installation and anchorage of pipelines greater than 8 inches in diameter.			●
e. Installation and anchorage of ductwork designed to carry hazardous materials.	Building Code		●
f. Installation and anchorage of ductwork greater than 6 square foot in cross section.			●
g. Installation and anchorage of vibration isolation systems where Contract Documents require nominal clearance of 1/4 inch or less between the equipment support frame and its support/restraint.	Building Code		●

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
h. Installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic fire sprinkler systems are installed.	Building Code		●
3. Fire-resistance elements:			
a. Fire-resistant penetrations and joint systems:	Building Code		●
4. Smoke control systems;	Building Code		●
Notes: (1) "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT C1 - MASONRY SPECIAL INSPECTION SCHEDULE - “LEVEL 3”

MASONRY SPECIAL INSPECTION SCHEDULE - "LEVEL 3"

MINIMUM VERIFICATIONS

Prior to construction, verification of compliance of submittals.

Prior to construction, verification of f'_m.

During construction, verification of Slump flow and Visual Stability Index (VSI) as delivered to the project site as determined by ASTM C1611 for self-consolidating grout.

During construction, verification of f'_m for every 5,000 sq. ft. in accordance with Specification Section 04220 - Concrete Unit Masonry.

During construction, verification of proportions of materials for premixed or pre-blended mortar, prestressing grout, and grout other than self-consolidating grout as delivered to the project site.

MINIMUM SPECIAL INSPECTION - LEVEL 3			
Verification and Inspection	**Reference Standard**	**Frequency of Inspection[(1)] (During Task Listed)**	
		Continuous	**Periodic**
1. Verify compliance with the approved submittals.	TMS 602/ACI 530.1		●
2. As masonry construction begins, verify that the following are in compliance:			
a. Proportions of site-prepared mortar.	TMS 602/ACI 530.1		●
b. Grade, type, and size of reinforcement, connectors, couplers, terminators, anchor bolts, and anchorages.	TMS 602/ACI 530.1 ICC-ES Evaluation Report		●
c. Sample panel construction.	TMS 602/ACI 530.1	●	
3. Prior to grouting, verify that the following are in compliance:			
a. Grout space.	TMS 602/ACI 530.1	●	
b. Placement of reinforcement, connectors, and anchor bolts.	TMS 602/ACI 530.1 TMS 402/ACI 530	●	
c. Proportions of site-prepared grout.	TMS 602/ACI 530.1		●

MINIMUM SPECIAL INSPECTION - LEVEL 3			
Verification and Inspection	**Reference Standard**	**Frequency of Inspection[(1)] (During Task Listed)**	
		Continuous	**Periodic**
4. Verify compliance of the following during construction:			
a. Materials and procedures with the approved submittals.	TMS 602/ACI 530.1		●
b. Placement of masonry units and mortar joint construction.	TMS 602/ACI 530.1		●
c. Size and location of structural members.	TMS 602/ACI 530.1		●
d. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction.	TMS 402/ACI 530	●	
e. Welding of reinforcement.	TMS 402/ACI 530	●	
f. Preparation, construction, and protection of masonry during cold weather (temperature below 40 degrees F) or hot weather (temperature above 90 degrees F).	TMS 602/ACI 530.1		●
g. Placement of grout is in compliance.	TMS 602/ACI 530.1	●	
5. Observe preparation of grout specimens, mortar specimens, and/or prisms.	TMS 602/ACI 530.1	●	
Notes: (1) "●" represents a required inspection activity for the project where it occurs.			

ATTACHMENT D - SOILS - SPECIAL INSPECTION SCHEDULE

SOILS - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[1] (During Task Listed)	
		Continuous	Periodic
1. Verify materials below shallow foundations are adequate to achieve the design bearing capacity.	Building Code		●
2. Verify excavations are extended to proper depth and have reached proper material.	Building Code		●
3. Perform classification and testing of fill and backfill materials.	Building Code		●
4. During fill placement, verify use of proper materials and procedures in accordance with the provisions of the approved geotechnical report. Verify densities and lift thicknesses during placement and compaction of compacted fill.	Building Code	●	
5. Prior to placement of fill, observe subgrade and verify that site has been prepared properly.	Building Code		●

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT E - STRUCTURAL STEEL WELDING - SPECIAL INSPECTION SCHEDULE

STRUCTURAL STEEL WELDING - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[(1)] (During Task Listed)	
		Continuous	Periodic
Inspection Tasks Prior to Welding	AISC 360		
1. Welder qualification records and continuity records.			●
2. WPS available.		●	
3. Manufacturer certifications for welding consumables available.		●	
4. Material identification (type/grade).			●
5. Welder identification system (fabricator/erector).			●
6. Fit-up groove welds (including joint geometry): • Joint preparation. • Dimensions (alignment, root opening, root face, bevel). • Cleanliness (condition of steel surfaces). • Tacking (tack weld quality and location). • Backing type and fit (if applicable).			●
7. Configuration and finish of access holes.			●
8. Fit-up of fillet welds: • Dimensions (alignment, gaps at root). • Cleanliness (condition of steel surfaces). • Tacking (tack weld quality and location).			●
9. Check welding equipment.			●
Inspection Tasks During Welding	AISC 360		
10. Use of qualified welders.			●
11. Control and handling of welding consumables: • Packaging. • Exposure control.			●
12. No welding over cracked tack welds.			●
13. Environmental conditions: • Wind speed within limits. • Precipitation and temperature.			●
14. WPS followed: • Settings on welding equipment. • Travel speed. • Selected welding materials. • Shielding gas type/flow rate. • Preheat applied. • Interpass temperature maintained (min/max). • Proper position (F, V, H, OH).			●

Verification and Inspection	Reference Standard	Frequency of Inspection[(1)] (During Task Listed)	
		Continuous	Periodic
15. Welding techniques: • Interpass and final cleaning. • Each pass within profile limitations. • Each pass meets quality requirements.			●
16. Placement and installation of steel headed stud anchors.			●
Inspection Tasks After Welding	AISC 360		
17. Welds cleaned.			●
18. Size, length, and location of welds.		●	
19. Welds meet visual acceptance criteria: • Crack prohibition. • Weld/base-metal fusion. • Crater cross section. • Weld profiles. • Weld size. • Undercut. • Porosity.		●	
20. Arc strikes.		●	
21. k-area.		●	
22. Backing removed and weld tabs removed (if required).		●	
23. Repair activities.		●	
24. Document acceptance or rejection of welded joint or member.		●	
25. No prohibited welds have been added without the approval of the EOR.			●

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT F - STRUCTURAL STEEL BOLTING - SPECIAL INSPECTION SCHEDULE

STRUCTURAL STEEL BOLTING - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection[(1)] (During Task Listed)	
		Continuous	Periodic
Inspection Tasks Prior to Bolting	AISC 360		
1. Manufacturer's certifications available for fastener materials.		●	
2. Fasteners marked in accordance with ASTM requirements.			●
3. Correct fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane).			●
4. Correct bolting procedure selected for joint detail.			●
5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements.			●
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used.			●
7. Protected storage provided for bolts, nuts, washers and other fastener components.			●
Inspection Tasks During Bolting	AISC 360		
8. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required.			●
9. Joint brought to the snug-tight condition prior to the pretensioning operation.			●
10. Fastener component not turned by the wrench prevented from rotating.			●
11. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges.			●
Inspection Tasks After Bolting	AISC 360		
12. Document acceptance or rejection of bolted connections.		●	

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

ATTACHMENT G - STEEL CONSTRUCTION - STEEL DECK; OPEN WEB STEEL JOISTS AND JOIST GIRDERS; AND COLD-FORMED STEEL TRUSSES - SPECIAL INSPECTION SCHEDULE

STEEL CONSTRUCTION - STEEL DECK; OPEN WEB STEEL JOISTS AND JOIST GIRDERS; AND COLD-FORMED STEEL TRUSSES - SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection(1) (During Task Listed)	
		Continuous	Periodic
1. Installation of cold-formed steel deck:			
a. Materials: Identification markings in accordance with ASTM standards specified in the approved construction documents.	Applicable ASTM material standards		●
b. Materials: Manufacturer's certified test reports.			●
c. Welding: Floor and roof deck welds.	AWS D1.3		●
2. Installation of open-web steel joints and joist girders:			
a. End connections - welded or bolted.	SJI specs		●
b. Bridging - horizontal or diagonal.	SJI specs		●
3. Installation of cold-formed steel trusses:			
a. Trusses 60 ft or greater: Inspect temporary and permanent installation restraints/bracing conform to approved truss submittal.	Building Code		●

Notes:

(1) "●" represents a required inspection activity for the project where it occurs.

SECTION 01460

CONTRACTOR QUALITY CONTROL PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor Quality Control Plan.

1.02 SUBMITTALS

A. Qualifications of the Contractor's Quality Control (CQC) Plan Manager.

B. Contractor's Daily Quality Control Report:
   1. Submit to Engineer within 1 day of completion of each inspection using the approved form.

C. Daily Inspection Report:
   1. Submit to Engineer at the end of each working day or no later than prior to the beginning of the next working day using the approved form.

1.03 CONTRACTOR'S INSPECTION OF THE WORK

A. Work performed by Contractor shall be inspected by the Contractor's CQC Plan Manager. Non-conforming Work and any safety hazards in the Work area shall be noted and promptly corrected.

B. No materials or equipment shall be used in Work without inspection and acceptance by Contractor's CQC Plan Manager.

1.04 QUALIFICATIONS

A. Contractor's CQC Plan Manager: Demonstrate having performed similar CQC functions on similar type projects. Submit records of personnel experience, training, and qualifying registrations.

B. Minimum qualifications: Candidate must have a minimum of 5 years of experience on projects of similar type and size.

1.05 COVERING WORK

A. Whenever Contractor intends to backfill, bury, cast in concrete, or otherwise cover any Work, notify Engineer not less than 24 hours in advance to request inspection before beginning any such Work of covering. Failure of Contractor to notify Engineer in accordance with this requirement shall be resolved according to Article 14 of the General Conditions.

1.06 CONTRACTOR'S QUALITY CONTROL PROGRAM

A. General: Establish and execute a Quality Control (CQC) Plan for Work. The plan shall establish adequate measures for verification and conformance to defined requirements by Contractor personnel and lower-tier Subcontractors (including Fabricators, Suppliers, and Subcontractors). This program shall be described in a Plan responsive to this Section.

B. CQC personnel:
   1. Contractor's CQC Plan Manager shall report to a Senior Project Manager of the Contractor and shall have no supervisory or managerial responsibility over the workforce.
   2. The Contractor CQC Plan Manager shall be on-site as often as necessary, but not less than the daily working hours specified in the Contract Documents to remedy and demonstrate that Work is being performed properly and to make multiple observations of Work in progress.
   3. The Contractor is to furnish personnel with assigned CQC functions reporting to the CQC Manager. Persons performing CQC functions shall have sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.

C. CQC Plan:
   1. Contractor's CQC Plan shall include a statement by the Senior Project Manager designating the CQC Plan Manager and specifying the authority delegated to the CQC Plan Manager to direct cessation or removal and replacement of defective Work.
   2. Describe the CQC program and include procedures, work instructions, and records. Describe methods relating to areas that require special testing and procedures as required by the specifications.
   3. Include specific instructions defining procedures for observing Work in process and comparing this Work with the Contract requirements (organized by specifications section).
   4. Describe procedures to ensure that equipment or materials that have been accepted at the Site are properly stored, identified, installed and tested.
   5. Include procedures to verify that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier Suppliers and/or Subcontractors.
   6. Commissioning quality control: Include procedures to verify that the commissioning requirements of the Contract Documents are integrated into the Contractor's CQC Plan and conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to the Contractor and the lower-tier Suppliers and/or Subcontractors.
   7. Include instructions for recording inspections and requirements for demonstrating through the Daily Inspection Reports that Work inspected was in compliance or a deficiency was noted and action to be taken.
   8. Procedures to preclude the covering of deficient or rejected Work.
   9. Procedures for halting or rejecting Work.
   10. Procedures for resolution of differences between the CQC Plan Manager and the production personnel.

11. Identify contractual hold/inspection points as well as any Contractor-imposed hold/inspection points.

D. Daily Inspection Report: Include, at a minimum:
   1. Inspection of specific work.
   2. Quality characteristics in compliance.
   3. Quality characteristics not in compliance.
   4. Corrective/remedial actions taken.
   5. Statement of certification.
   6. CQC Manager's signature, electronic signature is acceptable.
   7. Information provided on the daily report shall not constitute notice of delay or any other notice required by the Contract Documents.

E. Deficient and Non-conforming Work and Corrective Action: Include procedures for handling deficiencies and non-conforming Work. Deficiencies and non-conforming Work are defined as documentation, drawings, material, equipment, or Work not conforming to the indicated requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent reoccurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documents and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
   1. Personnel responsible for identifying deficient and non-complying items within Work.
   2. How and by whom deficient and non-compliant items are documented "in the field."
   3. The personnel and process utilized for logging deficient and non-compliant Work at the end of each day onto a deficiency log.
   4. Tracking processes and tracking documentation for deficient and non-conforming Work.
   5. Personnel responsible for achieving resolution of outstanding deficiencies.
   6. Include detailed procedures for the performance and control of special process (e.g., welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).

F. Audits: The CQC program shall provide for regularly scheduled documented audits to verify that CQC procedures are being fully implemented by Contractor and its Subcontractors. Audit records shall be made available to Engineer upon request.

G. Documented control/quality records:
   1. Establish methods for control of Contract Documents that describe how Drawings and Specifications are received and distributed to ensure the correct issue of the document being used. Describe how record document/drawing data are documented and furnished to Engineer.
   2. Maintain evidence of activities affecting quality. Including operating logs, records of inspection, audit reports, personnel qualification and certification records, procedures, and document review records.
   3. Maintain quality records in a manner that provides for timely retrieval and traceability. Protect quality records from deterioration, damage and destruction.

4. Develop a list of specific records as required by the Contract Documents that will be furnished to Engineer at the completion of activities.

H. Acceptance of CQC Plan: Engineer's acceptance of the CQC Plan shall not relieve Contractor from any of its obligations for performance of Work. Contractor's CQC staffing is subject to Engineer's review and continued acceptance. Owner, at its sole discretion, and without cause, may direct Contractor to remove and replace the CQC Plan Manager.
   1. Acceptance of the CQC Plan by the Engineer is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction.
   2. After acceptance of the CQC Plan, notify the Engineer in writing of any proposed change. Proposed changes are subject to acceptance by the Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 REFERENCE

A. American National Standards Institute (ANSI).

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

1.04 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Arrange with the Owner to provide adequate temporary electrical service. Owner will supply the electricity from its facilities for the Contractors use in connection with the performance of the Work at no charge to Contractor.
   2. Contractor may obtain temporary 480V electrical connection from Pull Box 9 (PB-9). Three #2/0 and one #4 ground copper conductors are existing from MCC-A, section 8 upper to PB-9. The wires are not terminated in MCC-A. At Contractor request, Owner will make available either 50-amp or 100-amp breaker that could be re-located to MCC-A for construction power. Contractor shall be responsible for interconnection of the above components for temporary power.
   3. Contractor is responsible for providing temporary connections (including any appurtenances, conduit, and wiring) to Owner's electrical facilities and safely routing temporary power as required for the performance of the Work.
   4. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
   5. Contractor to provide all labor and materials associated with temporary power, including the installation of all necessary protective devices.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.

2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
    a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.

C. Temporary heating, cooling, and ventilating:
1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:
1. Construct facilities necessary to furnish potable water for human consumption.
2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
3. Development of non-potable water supply:
    a. Post ample signs throughout the work area warning that plant water is not potable.
    b. Non-potable water is available from hydrants or hose valves within plant without cost. When combined demand of the Work and plant exceeds plant supply capacity, provide additional temporary supply capacity.
    c. Connections shall be metered and provided with backflow prevention.

E. Temporary sanitary facilities:
1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
2. Existing facility use is not allowed.
3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. Temporary fire protection:
1. Provide fire protection required to protect the Work and ancillary facilities.

G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in existing facilities: As specified in Section 01140 - Work Restrictions.

I. Temporary piping systems:
1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
2. Submit product data for piping, fittings, appurtenances, restraints, supports, and other components of the temporary piping system.
3. Submit information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment.
4. Any temporary piping used for potable water or connecting to process downstream of filtration shall be disinfected as specified in Section 01757 - Disinfection.
5. Contractor shall field route piping as needed and as field condition dictate, unless otherwise indicated on the Drawings, and determine appropriate

lengths of piping and quantity/type of pipe fittings needed to construct temporary piping system. Do not block access points such as stairs, doors, and walkways to existing facilities unless approved in writing by the Owner.

6. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends.
7. Temporary piping systems shall be installed in a manner that will not damage existing or new facilities.

1.05 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Provide devices in accordance with minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

H. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

I. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

J. Fences:
   1. The WTP site is currently permanently fenced. Adjustments to the fence line will be required as part of this project. Permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to Substantial Completion.
   2. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
      a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
   3. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
   4. Fence temporary openings when openings are no longer necessary.
   5. Stagging location is outside of the permanent fencing. Contractor will be responsible for fencing and securing the stagging location.

1.06 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 ACCESS ROADS

A. General:
   1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
   2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.

B. Off-site access roads:
   1. Build and maintain graded earth roads.
   2. Build roads only in public right-of-way or easements obtained by Owner.
   3. Obtain rights-of-way or easements when electing to build along other alignment.

C. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.
   2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.

3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
4. Maintain on-site access roads free of mud.
5. Provide controls to prevent vehicles leaving the site from tracking mud off the site onto the public right-of-way.

1.08 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

C. Surface water control:
   1. Comply with construction stormwater discharge regulation by local jurisdiction.
   2. Control all on-site surface water. Provide proper drainage so flooding of the site or adjacent property does not occur.
   3. Provide and maintain ample means and devices with which to promptly remove and properly dispose of all water entering the site.
   4. Immediately before suspension of construction operations for any reason, provide proper and necessary drainage of work site.
   5. Provide berms or channels as necessary to prevent flooding or saturation of subgrade. Promptly remove all water collecting in depressions.
   6. Dispose of water in a manner that will not cause damage to adjacent areas or facilities.

D. Erosion control:
   1. Use measures such as berms, dikes, dams, sediment basins, fiber mat netting, gravel, mulches, slopes, drains, and other erosion control devices or methods to prevent erosion and sedimentation.
   2. Reference Section 01573 Erosion and Sediment Control for additional product and method information.
   3. Provide construction and earthwork methods which control surface drainage from cut, fill, borrow, and waste disposal areas, to prevent erosion and sedimentation.
   4. Inspect earthwork during execution to detect any evidence of the start of erosion. Apply corrective measures as required.

E. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.09 FIELD OFFICES AND SHEDS

A. Contractor field office
   1. Maintain on Project Site weather tight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.
   2. Provide field office with adequate space to examine documents and provide lighting in that space.

B. Engineer field office:
   1. Provide field office on project site for the exclusive use of the Engineer, as follows:
      a. Size: Approximately 12 feet by 50 feet with 8-foot minimum ceiling height.
      b. Construction: Weather tight building constructed at the site, pre-manufactured building, or trailer.
      c. Layout approved by Engineer.
         1) Private offices: 3.
         2) Conference area: 1.
         3) Washroom: 1.
            a) Room partitioned off from the working area.
            b) Single water discharge to nearest approved sanitary facility.
            c) Flush toilet.
            d) Vented exhaust fan.
            e) Sink with hot and cold water.
            f) Mirror.
            g) Water heater: 10-gallon capacity.
            h) Toilet tissue holder.
            i) Paper towel holder.
         4) Closet with shelving: 1.
      d. Exterior materials:
         1) Weather-resistant and finished in one color acceptable to Engineer.
         2) Skirting for under pinning of field office.
      e. Orientation: The contractor field office and engineer field office shall be separated from each other, with entries opposite each other.
         1) Provide wood stairs with handrails for each entry.
         2) Porch landing 5 feet by 5 feet for each entry.
         3) Provide 12’ space between these two offices.
      f. Interior materials in offices:
         1) Sheet-type materials for walls and ceilings, prefinished or painted; resilient floors and bases.
         2) Insulate interior walls for noise attenuation.
      g. Openings:
         1) At least 8 windows (with operable sash, insect screens, and blinds).
         2) Entrance doors: Provide 2, each with cylinder lock and 4 keys.
      h. Exterior lighting over entrance doors.
      i. Fire extinguishers:
         1) Appropriate type fire extinguisher(s) for field office.
      j. Twenty 110 volts AC duplex receptacles with at least 4 in each office, 1 on each wall.

2. Provide following furnishings and equipment:
    a. For each office in engineer field office:
        1) Office desks: 30 inches by 60 inches, with 6 drawers (2 with locks).
        2) Padded, upholstered swivel arm multi-function ergonomic chairs.
        3) Bookcases: 1, with not less than 12 linear feet of shelves for each bookcase.
        4) Wastebasket
    b. Plan/conference table: 1, not less than 48 inches by 120 inches.
    c. Swivel chairs for conference table (adjustable and fully padded): 10.
    d. Metal filing cabinet: 1, 18 inches by 30 inches by 52 inches, 4 drawers with locks.
    e. Supply cabinet: 1, with not less than 15 square feet of shelves.
    f. Plan hold rolling stand of 12 binders: 1, with binders.
    g. Dry erase board 96 by 48 inches, magnetic: 2.
    h. Refrigerator: 15.0 cubic feet capacity.
    i. Microwave oven: 1.0 cubic feet.
3. Arrange and pay for:
    a. Weekly janitorial service, including dusting, floor cleaning (sweeping, vacuuming or mopping), and trash removal, and monthly comprehensive cleaning, including windows.
    b. Heating, ventilating, and air conditioning equipment in operating condition.
        1) Furnish maintenance and consumables.
    c. Electric wiring, power, and lighting fixtures capable of providing at least 75-foot candles of light on work surfaces.
    d. A continuous supply of toilet paper, paper hand towels and hand soap for each washroom.
    e. Bottled drinking water service with hot and cold dispenser including water cups.
    f. Provide and maintain First Aid Kit and Cabinet in accordance with ANSI Z 308.1, and OSHA requirements.
    g. Provide boot scraper and brush at each entrance.
    h. Maintain approach walks, decking, porches, and parking lot free of mud, water, and snow.
4. Locate field offices where directed – see orientation indicated above.
5. Have field office ready for occupancy within 2 weeks after start of the Work.
6. Parking: 10 hard surfaced parking spaces for use by Engineer and Owner connected to office by a hard surfaced walkway.

1.10 FIELD OFFICES DATA SERVICE AND EQUIPMENT

A. Provide the following data services for the duration of the project.

B. Contractor is responsible for maintenance of service and hardware.

C. Data service will be dedicated to the Engineer and Owner and not shared with any other party.

D. Contractor shall provide a durable and weather tight system for connecting the Engineer Field Office to the service provider’s facilities at the jobsite boundary.

E. Data service:
   1. Broadband Internet.
      a. Minimum Internet bandwidth speed:
         1) Download: 100 Million bits per second (Mbps).
         2) Upload: 10 Million bits per second (Mbps).
      b. Modem, if applicable
      c. Wi-Fi router and wired switch with RJ-45 connections in each office.
         1) WPA3-Enterprise encrypted wi-fi security

F. Printer/Scanner:
   1. Manufacturers: The following or equal:
      a. Canon Color Digital Multifunction printer (ImageRUNNER Advance C3330i).
   2. Functions:
      a. Print, scan, and sort 11 inch by 17 inch and smaller paper size.
      b. Send and receive Fax.
   3. Maintenance contract: Onsite maintenance for duration of project.
   4. Supplies: Paper (8 1/2 inch by 11 inch, 8 1/2 inch by 14 inch, and 11 inch by 17 inch) trays, toner, and other supplies for duration of project.

1.11 REMOVAL

A. Remove temporary facilities and controls before inspection for final Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01573

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation of erosion and sediment control filter fabric fences.
   2. Triangular filter fabric fences.
   3. Straw bale fences and brush berms used during construction and prior to final development of site.

B. Purpose of control fences is to contain pollutants from overland flow.
   1. Control fences are not for use in channelized flow areas.

1.02 SUBMITTALS

A. Manufacturer's catalog sheets and other product data on geotextile fabric.

1.03 REFERENCES

A. ASTM International (ASTM):
   1. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
   2. D4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus.
   3. D4491- Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes, and Related Products.
   6. D5665- Standard Specification for Thermoplastic Fabrics Used in Cold-Applied Roofing and Waterproofing.
   7. D6459 - Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Hillslopes from Rainfall-Induced Erosion.
   8. D6475 - Standard Test Method for Measuring Mass per Unit Area of Erosion Control Blankets.
   9. D6525 - Standard Test Method for Measuring Nominal Thickness of Rolled Erosion Control Products.
   10. D6567 - Standard Test Method for Measuring the Light Penetration of a Rolled Erosion Control Product (RECP).
   11. D6818 - Standard Test Method for Ultimate Tensile Properties of Rolled Erosion Control Products.

1.04 QUALITY ASSURANCE FOR EROSION CONTROL BLANKETS

A. Product shall be manufactured in accordance with a documented Quality Control Program. At a minimum, the following procedures and documentation shall be provided:
   1. Manufacturing Quality Control Program Manual.
   2. First piece inspection of products produced to assure component materials and finished product tolerances are within manufacturer specifications.
   3. Additional inspections for product conformance shall be conducted during the run after the first piece inspection.
   4. Every roll shall be visually inspected.
   5. Moisture content of straw and coconut fibers measured upon receipt.
   6. At a minimum, every third roll shall be weighed to ensure conformance of manufacturer's specifications.
   7. Each individual erosion control blanket shall be inspected prior to packaging for conformance to manufacturing specifications.

1.05 PERFORMANCE REQUIREMENTS FOR EROSION CONTROL BLANKETS

A. Erosion control blanket shall provide a temporary, biodegradable cover material to reduce slope and enhance vegetation. Erosion control blanket performance capabilities shall be in accordance with ASTM D6459, "Determination of Erosion Control Blanket (ECB) Performance in Protecting Hillslopes from Rainfall-Induced Erosion."

PART 2 PRODUCTS

2.01 FILTER FABRIC

A. Provide woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material.

B. Geotextile fabric:
   1. Grab strength of 100 pounds per square inch in any principal direction in accordance with ASTM D4632.
   2. Puncture strength exceeding 115 pounds per square inch in accordance with ASTM D4833.
   3. Equivalent opening size between 50 and 140 for soils with more than 15 percent by weight passing No. 200 sieve and between 20 and 50 for soil with less than 15 percent by weight passing No. 200 sieve.
   4. Maximum water flow rate of 40 gallons per minute per square feet in accordance with ASTM D4491.

C. Filter fabric material shall contain ultraviolet inhibitors and stabilizers to provide expected usable life comparable to anticipated construction period.
   1. Ultraviolet stability shall exceed 70 percent after 500 hours of exposure in accordance with ASTM D4355.

D. Manufacturers: The following or equal:
   1. Mirafi, Inc.

2.02 EROSION CONTROL BLANKETS

A. Manufacturers: One of the following, or equal:
   1. American Excelsior Co., AEC Premier Straw/Coconut™ Blankets.
   2. Proper Geotextile Systems.

B. Product requirements:
   1. Furnished in rolls and wrapped with suitable material to protect against moisture intrusion and extended ultraviolet exposure prior to placement.
   2. Consistent thickness with fibers distributed evenly over the entire area of the blanket.
   3. Free of defects and voids that would interfere with proper installation or impair performance.

C. Materials:
   1. Blend of 70 percent straw and 30 percent coconut fibers.
      a. Straw fibers shall consist of straw with 75 percent of fibers greater than 4 inches in length, and certified weed seed free.
      b. Product shall be 100 percent biodegradable.
      c. Blended fibers shall be evenly distributed throughout the entire area of the blanket.
      d. Top and bottom of each blanket is covered with biodegradable jute netting.
   2. Blanket performance requirements:
      a. C factor: 0.15.
      b. Shear stress: 2.0 lb/ft^2.
      c. Velocity: 8.5 feet per second.
      d. Functional longevity: Less than 24 months.
   3. Material characteristics:
      a. Width: 8.0 feet.
      b. Length: 112.5 feet.
      c. Area: 100.0 $yard^2$.
      d. Weight: 50.0 pounds.
      e. Mass per unit area: 0.50 lv/yd^2.
      f. Net openings: 0.5 inch by 1.0 inch.
      g. Minimum index values:

Index Property	Test Method	Value
Thickness	ASTM D6525	0.331 in (8.41 mm)
Light Penetration	ASTM D6567	5.8 percent
Mass per Unit Area	ASTM D6475	0.81 lb/yd^2 (437 g/m^2)
MD-Tensile Strength Max.	ASTM D6818	321.6 lb/ft (4.69 kN/m)
TD-Tensile Strength Max.	ASTM D6818	159.6 lb/ft (2.33 kN/m)
MD-Elongation	ASTM D6818	4.1 percent
TD-Elongation	ASTM D6818	4.8 percent
Water Absorption	ASTM D5665	382 percent

D. Staples:
   1. 100 percent biodegradable with a U-shaped top.

2. Minimum 4 inch biodegradable staple for cohesive soils and 6 inches for non-cohesive soils.

PART 3 EXECUTION

3.01 PREPARATION AND INSTALLATION

A. Provide erosion and sediment control systems at all disturbed Project site work areas including finished graded slopes.
   1. Construct in accordance with requirements of method and of type selected as specified in this Section.

B. No clearing, grubbing or rough cutting permitted until erosion and sediment control systems are in place, other than site work specifically directed by Project Manager to allow soil testing and surveying.

C. Maintain existing erosion and sediment control systems located within Project site until acceptance of Project or until directed by Project Manager to remove and discard existing system.

D. Regularly inspect and repair or replace damaged components of erosion and sediment control systems as specified in this Section.
   1. Unless otherwise directed, maintain erosion and sediment control systems until Project area stabilization is accepted by the Authority.
   2. Remove erosion and sediment control systems promptly when directed by Project Manager.
   3. Discard removed materials off site.

E. Remove and dispose sediment deposits at designated spoil site for Project.
   1. If a Project spoil site is not indicated on the Drawings, dispose of sediment off site at location not in or adjacent to stream or floodplain.
   2. Assume responsibility for off-site disposal.
   3. Spread sediment evenly throughout site, compacted and stabilized.
   4. Prevent sediment from flushing into a stream or drainage way.
   5. If sediment has been contaminated, dispose of in accordance with existing federal, state, and local rules and regulations.

F. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8-inch layers.
   1. Compaction density shall be at a minimum of 90 percent Standard Proctor ASTM D698 density.
   2. Make at least 1 test per 500 cubic yards of embankment.

G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights-of-way and easements for construction.
   1. Immediately repair damage caused by construction traffic to erosion and sediment control.

H. Conduct construction operations under this Contract in conformance with erosion control practices described in Section 02370 - Riprap and Gabions Erosion and Sedimentation Control.

3.02 GENERAL CONSTRUCTION METHODS

A. Provide erosion and sedimentation control systems as at all disturbed Project site work areas.
   1. Install erosion and sedimentation control systems in manner that surface runoff shall percolate through system in sheet flow fashion and allow retention and accumulation of sediment.

B. Inspect erosion and sedimentation control systems after each rainfall, daily during periods of prolonged rainfall, and at minimum once each week.
   1. Repair or replace damaged sections immediately.
   2. Remove sediment deposits when silt reaches depth 1/3 height of fence or 6 inches, whichever is less.

3.03 SITE PREPARATION FOR EROSION CONTROL BLANKETS

A. Before placing erosion control blankets, certify that the subgrade has been properly compacted, graded smooth, has no depressions, voids, soft or uncompacted areas, is free from obstructions such as tree roots, protruding stones or other foreign matter, and is seeded and fertilized according to Project specifications.
   1. Contractor shall not proceed until unsatisfactory conditions have been remedied.
   2. By beginning construction, Contractor signifies that the proceeding work is in conformance with this Section.

B. Fine grade the subgrade by hand dressing where necessary to remove local deviations.

C. No vehicular traffic shall be permitted directly on the erosion control blanket.

D. Slope installation.
   1. Erosion control blankets shall be installed as directed by Owner's representative in accordance with manufacturer's Installation Guidelines, Staple Pattern Guides, and CAD details. The extent of erosion control blankets shall be as necessary to minimize sediment transport from stormwater runoff.
   2. Erosion control blankets shall be oriented in vertical strips and anchored with staples, as identified in the Staple Pattern Guide.
      a. Adjacent strips shall be overlapped to allow for installation of a common row of staples that anchor through the nettings of both blankets.
      b. Horizontal joints between erosion control blankets shall be sufficiently overlapped with the uphill end on top for a common row of staples so that the staples anchor through the nettings of both blankets.
   3. Where exposed to overland sheet flow, a trench shall be located at the uphill termination erosion control blanket shall be stapled to the bottom of the trench.
      a. Trench shall be backfilled and compacted.
      b. Where feasible, the uphill end of the blanket shall be extended 3 feet over the crest of the slope.

3.04 FILTER FABRIC FENCE CONSTRUCTION METHODS

A. Attach filter fabric to 1-inch by 2-inch wooden stakes or driven steel rods spaced a maximum of 3 feet apart and embedded minimum of 8 inches or deeper to hold fence in place.
   1. If filter fabric is factory preassembled with support netting, then maximum spacing allowable is 8 feet.
   2. Install anchoring stakes or rods at slight angle toward source of anticipated runoff.
   3. Contractor is responsible for providing adequate fence anchoring appropriate for the varying soil and rock conditions at the well sites.

B. Trench in toe of filter fabric fence with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow.
   1. V-trench configuration may also be used with approval from Owner's representative.
   2. Lay filter fabric along edges of trench.
   3. Backfill and compact trench.

C. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.

D. Provide filter fabric in continuous rolls and cut to length of fence to minimize use of joints.
   1. When joints are necessary, splice fabric together only at support post with minimum 6-inch overlap and seal securely.

3.05 TRIANGULAR FILTER FABRIC FENCE CONSTRUCTION METHODS

A. Attach filter fabric to fence structure fashioned from 6 gauge, 6-inch by 6-inch wire mesh, 18 inches on each side.
   1. Fabric cover and skirt should be continuous wrapping of fabric.
   2. Skirt should form continuous extension of fabric on upstream side of fence.

B. Secure triangular fabric filter fence in place using one of the following methods:
   1. Toe-in skirt 6 inches with mechanically compacted material.
   2. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock.
   3. Trench-in entire structure 4 inches.

C. If provided, anchor triangular fabric filter fence structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt, or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.

D. Lap over fabric filter material by 6 inches to cover segment joints.
   1. Fasten joints with galvanized shoat rings.

3.06 STRAW BALE FENCE CONSTRUCTION METHODS

A. Bound bales with either wire, nylon or polypropylene rope tied across hay bales.
   1. Do not use jute or cotton bindings.

B. Place bales in row with ends tightly abutting adjacent bales.
   1. Place bales with bindings parallel to ground surface.

C. Embed bale in soil a minimum of 4 inches.

D. Securely anchor bales in place by 3/8-inch rebar stakes driven through bales a minimum of 18 inches into ground.
   1. Angle first stake in each bale toward previously laid bale to force bales together.

E. Fill gaps between bales with straw to prevent water from escaping between bales.
   1. Wedge carefully in order not to separate bales.

F. Replace with new straw bale fence every 2 months.

3.07 BRUSH BERM CONSTRUCTION METHODS

A. Construct brush berm along contour lines by hand placing method.
   1. Do not use machine placement of brush berm.

B. Use woody brush and branches having diameter less than 2 inches with 6 inches overlap.
   1. Avoid incorporation of annual weeds and soil into brush berm.

C. Use minimum height of 18-inches measured from top of existing ground at upslope toe to top of berm.
   1. Top width shall be 24 inches minimum and side slopes shall be 2:1 or flatter.

D. Embed brush berm into soil a minimum of 4-inches and anchor using either wire, nylon or polypropylene rope across berm with a minimum tension of 50 pounds.
   1. Tie rope securely to 18-inch by 3/8-inch diameter rebar stakes driven into ground on 4-foot centers on both sides of berm.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for tangible materials, raw or manufactured, that become part of the project.

1.02 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when this Section is referenced in other Specifications, have the indicated meaning.
   1. Calculations:
      a. Documentation of the process of transforming the design and prescriptive criteria into a design meeting the performance criteria.
   2. Certificates:
      a. An official document that attests a fact is in accordance with the Contract Documents.
   3. Manufacturer's instructions:
      a. Stipulations, directions, and/or recommendations issued by the manufacturer of the product addressing handling, storage, installation, protection, erection, and/or application of the product.
   4. Products:
      a. Raw materials, finished goods, equipment, systems, and shop fabrications that will become part of the Work.
   5. Product data:
      a. Information about the product, which is typically found in the manufacturer's catalogs or on their web site, including data sheets, bulletins, layout drawings, exploded views, and brochures.
   6. Samples:
      a. As defined in the General Conditions and Supplementary Conditions.
      b. Full-size actual products or pieces of products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.
   7. Shop Drawings:
      a. As defined in the General Conditions and Supplementary Conditions.
      b. Shop Drawings are prepared specifically for the project to illustrate details, dimensions, and other data necessary for satisfactory fabrication or construction.
      c. Shop Drawings could include graphic line-type drawings and single-line diagrams.

8. Spare parts and materials:
    a. Duplicate parts necessary to replace a damaged or worn part of the product.
    b. Consumables such as operating fluids.
9. Special tools:
    a. Special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a product that would not normally be in the Owner's tool kit and that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.
10. Submittals:
    a. As defined in the General Conditions and Supplementary Conditions.
    b. Samples, product data, Shop Drawings, and other materials that demonstrate how Contractor intends to conform to the Contract Documents.

1.03 SHIPMENT

A. Requirements prior to shipment of equipment:
    1. Engineer approved Submittals or other written documentation.
    2. Engineer approved Manufacturer’s Certificate of Source Testing as specified in the Technical Sections.
    3. Draft operations and maintenance manuals, as specified in Section 01782 - Operation and Maintenance Manuals as specified in the Technical Sections.

B. Transport products by methods that avoid product damage.

C. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

1.04 DELIVERY AND HANDLING

A. Handle equipment in accordance with manufacturer's instructions.

B. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

C. Provide construction equipment and personnel to handle products by methods in accordance with manufacturer’s instructions.

D. Upon delivery, promptly inspect shipments:
    1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
    2. Acceptance of shipment does not constitute final acceptance of equipment.

E. Spare parts, maintenance products, special tools.
    1. Immediately store in accordance with the manufacturer's instructions.

2. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period.
    a. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
3. With Owner's written request for advanced delivery of spare parts, maintenance products, and special tools.
    a. Deliver requested items and deduct them from the inventory list.
    b. Provide transmittal documentation.
4. Store large items individually:
    a. Weight: Greater than 50 pounds.
    b. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
    c. Clearly labeled:
        1) Equipment tag number.
        2) Equipment manufacturer.
        3) Subassembly component, if appropriate.
        4) Store smaller items in spare parts box:
    d. Weight: Less than 50 pounds.
    e. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
    f. Clearly labeled:
        1) Equipment tag number.
        2) Equipment manufacturer.
        3) Subassembly component, if appropriate.
        4) Spare parts and special tools box:
    g. Box material: Waterproof, corrosion resistant.
    h. Hinged cover:
        1) Locking hasp.
    i. Spare parts inventory list taped to underside of cover.
    j. Clearly labeled:
        1) “Spare Parts and/or Special Tools”.
        2) Equipment tag number.
        3) Equipment manufacturer.
        4) Subassembly component, if appropriate.

1.05 STORAGE

A. Storage of equipment to be in accordance with the manufacturer’s instructions.
    1. Including connection of motor heaters, lubrication, manually rotating shafts, etc.
    2. Contractor shall furnish a copy of the manufacturer’s instructions for storage to the Engineer prior to storage of equipment and materials.

B. Immediately store and protect products until installed in Work.

C. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, architectural items, electrical and instrumentation equipment and special equipment to be incorporated into this project.

D. Store products with seals and legible labels intact.

E. Protect painted or coated surfaces against impact, abrasion, discoloration, and damage.

F. Storage of spare parts, maintenance products, special tools.
   1. Immediately store in accordance with the manufacturer's instructions.
   2. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period.
   3. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.
   4. Store large items individually:
      a. Weight: Greater than 50 pounds.
      b. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
      c. Clearly labeled:
         1) Equipment tag number.
         2) Equipment manufacturer.
         3) Subassembly component, if appropriate.
   5. Store smaller items in spare parts boxes:
      a. Weight: Less than 50 pounds.
      b. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
      c. Clearly labeled:
         1) Equipment tag number.
         2) Equipment manufacturer.
         3) Subassembly component, if appropriate.
   6. Spare parts and special tools box:
      a. Box material: Waterproof, corrosion resistant.
      b. Hinged cover with locking hasp:
      c. Inventory list taped to underside of cover.
         1) Clearly labeled:
            a) “Spare Parts and/or Special Tools”.
            b) Equipment tag number.
            c) Equipment manufacturer.
            d) Subassembly component, if appropriate.

G. Exterior storage of fabricated products:
   1. Place on aboveground supports that allow for drainage.
   2. Cover products subject to deterioration with impervious sheet covering.
   3. Provide ventilation to prevent condensation under covering.

H. Store moisture sensitive products in watertight enclosures.

I. Store loose granular materials on solid surfaces in well-drained area.
   1. Prevent materials mixing with foreign matter.
   2. Provide access for inspection.

J. Provide an equipment log and stored products log with monthly pay applications.
   1. Include: Storage location, equipment or product identification, date stored, date of inspection/maintenance, date removed from storage, copy of manufacturer’s recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

K. When needed and approved by the Engineer, offsite storage location shall be within 20 miles of the project site.
   1. Provide proof of insurance coverage for products stored offsite.

L. Payment will not be made for equipment and materials improperly stored or stored without providing Engineer with the manufacturer's instructions for storage.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Provide products as Engineer has approved by the Submittal process or by other written documents.

B. Provide products by same manufacturer when units are of similar nature, unless otherwise specified.

C. Provide like parts of duplicate units that are interchangeable.

D. Provide equipment or product that has not been in service prior to delivery, except as required by tests.

E. Provide products produced by manufacturers regularly engaged in the production of these products.

F. Provide products that bear approvals and labels as specified such as Factory Mutual (FM), Underwriters Laboratory (UL), or National Sanitation Foundation (NSF International) that are acceptable to the Authority Having Jurisdiction.

2.02 MATERIAL

A. Dissimilar metals:
   1. Separate contacting surfaces with dielectric material.
   2. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.

B. Edge grinding:
   1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence.

C. Use anti-galling compound on threads of stainless steel fasteners during factory assembly.

D. Provide anti-galling compound with stainless steel fasteners shipped for field assembly.

E. Aluminum in contact with concrete or masonry: Apply epoxy mastic as specified in Section 09960 - High-Performance Coatings, coating system EPX-M-5.

F. Pipes:
   1. Provide new pipe manufactured for the following:
      a. Piping 24-inch diameter and larger.
      b. AWWA C200 steel piping.
   2. Piping provided from manufacturers/distributors inventory is subject to the following condition:
      a. Provide proof pipe manufactured more than 6 months prior to delivery was stored properly and the material and/or coating was not subjected to ultraviolet (UV) degradation.
   3. Mark each length of pipe in accordance with applicable standards.

2.03 PRODUCT SELECTION

A. When products are specified without named manufacturers, provide products that meet or exceed the Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide products by one of named manufacturers that meet or exceed specifications.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide products with model numbers or catalog designations by one of the named manufacturers.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by another named manufacturers proven, in accordance with requirements for an “or equal”, including Engineer’s approval, to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.

E. When products are specified with only one manufacturer followed by “or Equal,” provide:
   1. Products meeting or exceeding Specifications by specified manufacturer.
   2. Engineer deemed “or equal” evidenced by an approved Shop Drawing or other written communication.

F. When products are specified by naming 2 or more manufacturers with 1 manufacturer as a “Basis of Design”:
   1. Any of the named manufacturers can be submitted.
   2. If the product submitted is not by the named “Basis of Design” product and requires a change in the scope (dimensions, configuration, physical properties, etc.), schedule (longer lead time), or budget, the Contractor must submit a substitution request.

G. Materials in contact with drinking water: Must be certified in compliance with NSF 61 and NSF 372 and certified by an independent ANSI accredited third party, including, but not limited to, NSF International, as being lead free.

2.04 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts and maintenance products as required by Technical Sections.
   1. Submit completed Attachment A - Spare Parts, Maintenance Products, and Special Tools Inventory List.

B. Provide one set of special tools required to install or service the equipment.

C. Box, tag, and clearly mark items.

D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by Owner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Inspect equipment or product prior to product installation.

B. Repaint or recoat damaged painted or coated surfaces.

C. Use anti-galling compound on stainless steel threads used for field assembly.

3.02 PROTECTION AFTER INSTALLATION

A. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations.
   1. Remove covering when no longer needed.
   2. Replace corroded, damaged, or deteriorated equipment, product, or parts before acceptance of the project.

B. Update equipment log with monthly pay applications.
   1. Data includes as a minimum: Description of maintenance activities performed in accordance with the manufacturer's recommendation and industry standards and signature of party performing maintenance.

END OF SECTION

ATTACHMENT A - SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

Inventory List				
Spec Number: _____		Spec Title _____		
Equipment Tag No.: _____		Equipment Manufacturer: _____		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**

SECTION 01722

FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Field engineering to establish lines and grades for the Work.

1.02 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Qualifications of the professional land surveyor or licensed civil engineer with the authority to provide land surveying in Utah that will be performing the field engineering.

C. Pre-Excavation Report.

1.03 PRE-EXCAVATION REPORT

A. Prior to the start of the Work, create a report confirming the verification of the following data:
   1. Site elevation.
   2. Existing structures, including, but not limited to, buildings, manholes (sanitary, storm, electrical, and other), drainage inlets:
      a. Location coordinates.
      b. Top of wall elevation and coordinates.
      c. Floor elevations.
      d. Invert elevations.
   3. Existing utilities.
   4. Proposed building corners, tank, and equipment locations.
   5. Verify existing electrical, instrumentation, and phone utilities.

B. Incorporate information from Pre-Excavation Report into the Record Drawings.

C. Existing utilities indicated on the Drawings are approximate only and are provided based on the best information available by use of reports listed in Supplemental General Conditions.

D. Existing utilities are shown for the convenience of Contractor only.
   1. It is the Contractor’s responsibility to field verify the vertical and horizontal location of all utilities including those not indicated or incorrectly indicated on the Drawings.

E. Contractor is responsible to review all geotechnical reports, record drawings, and Contract Documents.

F. Coordinate with utility locator, such as CALL BEFORE YOU DIG, and other affected entities when they have jurisdiction over the project site.

G. Contractor is responsible for protecting all utilities encountered.
   1. Before any excavation, follow requirements of Section 01140 - Work Restrictions.
   2. If a conflict exists between what is indicated on the Drawings and what exists in the field, Contractor shall notify Engineer immediately.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SURVEY REFERENCE POINTS

A. Basic reference line, a beginning point on basic reference line, points with referenced coordinates, and a benchmark will be provided by the Owner.

B. From these reference points, establish other control and reference points as required to properly lay out the Work.

C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
   1. Make no changes or relocations without prior written notice.
   2. Replace Project control point, when lost or destroyed, in accordance with original survey control.

D. Set monuments for principal control points and protect them from being disturbed and displaced:
   1. Re-establish disturbed monuments.
   2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

3.02 PROJECT SITE SURVEY REQUIREMENTS

A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.

B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.

C. Perform verifications and checking in accordance with industry standard surveying practice.

D. Maintain complete, accurate log of control points and survey.

E. Affix civil engineer’s or professional land surveyor’s signature and license number to Record Drawings to certify accuracy of information shown.

3.03 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

3.04 QUALITY CONTROL

A. Accuracy of stakes, alignments, and grades may be checked randomly by the Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Engineer's check does not substitute or complement required field quality control procedures.

3.05 RECORD DOCUMENTS

A. Prepare and submit Record Documents as specified in Section 01770 - Closeout Procedures.

END OF SECTION

SECTION 01738

SELECTIVE ALTERATIONS AND DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cutting or modifying existing and new Work.
   2. Partial demolition of structures.
   3. In-place abandonment of pipe.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A10.6 - Safety and Health Program Requirements for Demolition Operations.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
   2. Guideline No. 310.3R - Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods.

1.03 DEFINITIONS

A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.

B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.

C. Coring equipment: Non-impact rotary drill with diamond cutting edges.

D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

E. Salvage material: Materials removed from existing facilities and stored for Owner's future reuse.

1.04 DESCRIPTION OF WORK

A. The work includes partial demolition, cutting, and modifying existing facilities, utilities, and/or structures.

B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and structures that are to remain in place and that are damaged by demolition or removal operations.

1.05 SUBMITTALS

A. General:
   1. Submit specified in Section 01330 - Submittal Procedures.

B. Shop drawings: Include:
   1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.

C. Submittals for information only:
   1. Permits and notices authorizing demolition.
   2. Certificates of severance of utility services.
   3. Permit for transport and disposal of debris.
   4. Selective Demolition Plan.
   5. Pipe Abandonment Plan.

D. Quality assurance submittals:
   1. Qualifications of non-destructive testing agency/agencies.

E. Project record documents.

F. Drawings and/or other media documenting locations of service lines and capped utilities.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
   2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

1.07 SEQUENCING

A. Perform Work in sequences and within times specified in Section 01140 - Work Restrictions.

B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.

C. Coordinate the Work with operation of the facility:
   1. Do not begin alterations of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
   2. Complete Work as quickly and with as little delay as possible.

D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.

E. Owner will cooperate to assist in expediting the Work.

F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

1.08 REGULATORY REQUIREMENTS

A. Dispose of debris in accordance with governing regulatory agencies.

B. Comply with applicable air pollution control regulations.

C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

1.09 PREPARATION

A. Non-destructive evaluation of existing concrete:
   1. Prior to cutting, drilling, coring, and/or any other procedure that penetrates existing concrete, retain and pay for the services of a qualified non-destructive testing agency to perform investigations to determine the location of existing steel reinforcement, plumbing, conduit, and/or other embedments in the concrete.
   2. Submit documentation of the investigations to the Engineer for review and approval as specified in Section 01330 - Submittal Procedures, before any work involving penetration of existing concrete is initiated.

1.10 PROJECT CONDITIONS

A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.

B. Provide, erect, and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
   1. Do not close or obstruct roadways without permits.
   2. Conduct operations with minimum interference to public or private roadways.

C. Prevent movement, settlement, or collapse of structures adjacent services, sidewalks, driveways and trees:
   1. Provide and place bracing or shoring.
   2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
   3. Assume liability for movement, settlement, or collapse. Promptly repair damage.

D. Arrange and pay for capping and plugging utility services. Disconnect and stub off.
   1. Notify affected utility company in advance and obtain approval before starting demolition.
   2. Place markers to indicate location of disconnected services.

E. Unknown conditions:
   1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
   2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other surface fixtures.
   3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the Work until written instructions are received from the Engineer.

PART 2 PRODUCTS

2.01 SALVAGE MATERIALS

A. Materials designated for salvage are indicated on drawings.

B. Handling and storage:
   1. Prevent damage to salvaged materials during removal and handling.
   2. Salvage items shall be relinquished to owner onsite.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning selective demolition operations, perform a thorough inspection of the facility and site.
   1. Report to the Engineer defects, structural damage, and deterioration of existing construction to remain in place.

B. Examine areas affected by the Work and verify the following conditions prior to commencing demolition:
   1. Disconnection of utilities as required.

2. Verify that utilities serving occupied or active portions of surrounding facilities will not be disturbed, except as otherwise indicated.

C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition operations until such conditions have been corrected.

3.02 PREPARATION

A. Plan and organize Work to minimize inconvenience to adjacent buildings and to plant operations. All requirements for handling of any hazardous materials must be in place prior to beginning demolition. See Section 01354 - Hazardous Materials Procedures.

B. Selective Demolition Plan:
   1. Prepare and submit a comprehensive selective demolition plan for the Work including the following elements, at a minimum:
      a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
      b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
   2. Plan shall be signed and sealed by a Professional Engineer registered in the state where Project is located.
   3. Submit plan a minimum 4 weeks before demolition is scheduled to begin.

C. Pipe Abandonment Plan:
   1. Prepare and submit a comprehensive Pipe Abandonment Plan for the Work.
      a. Include provisions to demonstrate and verify with camera inspection that all solids have been removed and that pipe is free of residuals.
   2. At a minimum, define the following elements:
      a. Proposed sequence, methods, cleaning procedures, or demolition, removal, and disposal of contents of the piping.
      b. Method of verification of final pipe condition.
      c. Detailed drawings showing treatment of pipe ends**.**
   3. Submit plan a minimum 4 weeks before abandonment is scheduled to begin.

D. Protection:
   1. Erect weatherproof closures to protect the interior of facilities and elements or equipment that are not designed for exposure to the weather.
   2. Provide temporary heat, cooling, and humidity control as necessary to prevent damage to existing and new equipment and construction.
   3. Maintain existing exiting paths and/or provide new paths in compliance with Building Code requirements.
   4. Erect and maintain dustproof partitions as required to prevent spread of dust, to other parts of building. Maintain negative pressure in the area where the Work is being performed to prevent the accidental spread of dust and to minimize the spread of fumes related to the Work.
   5. Upon completion of Work, remove weatherproof closures and dustproof partitions.
   6. Repair damaged surfaces to match adjacent surfaces.
   7. Provide and maintain protective devices to prevent injury from falling objects.

8. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
9. Protect the following from damage or displacement during Work.
    a. Benchmarks and survey points.
    b. Existing construction that will remain in place.
    c. Trees and landscaping designated to remain in place.
10. Carefully remove designated materials and equipment to be salvaged by Owner or reinstalled.
11. Store and protect materials and equipment to be reinstalled.

E. Layout:
1. Confine demolition operations to the minimum area required.
2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required.
3. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.
4. Arrange for Engineer's inspection of the layout extents.
5. Do not begin demolition/removal operations until the layout markings have been reviewed by the Engineer.

3.03 DEMOLITION

A. General:
1. Perform demolition work in accordance with ANSI A10.6.
2. Demolish designated portions of structures and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.
3. Conduct demolition and removal work in a manner that will minimize dust and flying particles.
    a. Use water or dust palliative when necessary to prevent airborne dust.
    b. Provide and maintain hoses and connections to water main or hydrant.
4. Remove materials carefully, to the extent indicated and as required.
    a. Provide neat and orderly junctions between existing and new materials.
    b. Use methods that terminate surfaces in straight lines at natural points of division.
5. Do not remove anything beyond the limits of Work indicated without prior written authorization from the Engineer.
    a. If in doubt about whether to remove an item, obtain written authorization from the Engineer prior to proceeding.
6. Perform work so as to provide the least interference and most protection to existing facilities to remain.
7. Demolished materials:
    a. Assume possession of materials unless otherwise indicated on the Drawings or specified.
    b. Remove demolished materials from site at least weekly and dispose of them in accordance with Laws and Regulations.
    c. Do not burn or bury materials on site.

B. Demolition of concrete and masonry:
1. Demolish concrete and masonry in small sections.
    a. Perform demolition with small tools as much as possible.
    b. Blasting with explosive charges is not permitted.

2. Sawcut concrete to establish the edges of demolition, wherever possible.
    a. Do not use a concrete breaker within 6 inches of reinforcing or structural metals that are designated to remain in place.
    b. At edges that are not sawcut, remove the final 6 inches of material with a chipping hammer as defined herein. At surfaces where material is removed with a chipping hammer, follow with a heavy abrasive blast to remove all loose material and microcracking.
    c. Alternate techniques to remove concrete may be used if acceptable to the Engineer; however, techniques other than those deemed by ICRI Guideline No. 310.2R to provide a low risk of introducing microcracking will require a subsequent procedure to remove loose material and microcracked.
    d. Provide final surface preparation for repairs as required.
3. At locations where the existing reinforcing is to be preserved, remove concrete using methods that do not damage the reinforcing. Use one of the following techniques:
    a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
    b. Chipping hammer, as defined herein, followed by heavy abrasive blast to remove all loose material and microcracking at remaining surfaces impacted by the chipping hammer.
    c. Alternate methods may be used only when accepted in advance by the Engineer.
    d. For all methods, provide a small, completed area for Engineer's review and acceptance. If the proposed method, in the opinion of the Engineer, damages the reinforcing, revise the removal method to remove the concrete with a less aggressive technique to protect the reinforcing.

C. Sizing of openings in existing concrete or masonry:
1. Make openings large enough to permit final alignment of pipe and fittings without deflections, but without oversizing.
2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
3. If the Engineer deems the opening to be insufficient in size to accomplish these criteria, remove additional material using the procedures outlined in this Section.

D. Cutting openings in existing concrete or masonry:
1. Do not allow saw cuts to extend beyond limits of openings.
2. Create openings by the following method or other means acceptable to the Engineer that prevents over-cutting of member at corners:
    a. Core-drill through slab or wall at corners, being careful not to damage materials beyond the area to be removed.
    b. Saw cut completely through the member, between the core holes at the corners.
    c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth.
        1) Provide score on both surfaces (when accessible).
        2) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
        3) Remove the remaining material with a chipping hammer.

d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.

2. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

E. In-place Abandonment of Pipe:
1. Abandoned pipe in-place as indicated on the Drawings.
2. Clean buried or exposed solids service piping to a condition free of residual.
a. Provide closure of abandoned pipe cut ends. Install cap or plug on pipe end unless otherwise indicated on drawings.

F. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.

G. Remove trees and shrubs within marked areas, and clear undergrowth and dead plant material as specified in Section 02300 - Earthwork.

H. Backfill open pits and holes caused by demolition as specified in Section 02300 - Earthwork.

I. Rough grade areas affected by demolition.

J. Remove demolished materials, tools, and equipment upon completion of demolition.

3.04 RESTORATION

A. General:
1. Repair damage caused by demolition to conditions equal to those that existed prior to beginning of demolition.
a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface, and that matches color and texture of adjacent surfaces.
b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
2. The cost of repairs shall be at the Contractor’s expense at no increase in the Contract Price.
3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.
5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
a. Where change of plane between adjacent surfaces exceeds 2 inches, request and obtain instructions for making transition from Engineer.
1) Refinish door surfaces and edges as necessary.
6. Trim existing doors as necessary to clear new floors.
7. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.

8. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

B. Restore existing concrete reinforcement as follows:
   1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, conduits, and fasteners so little or no evidence of the previous installation remains:
   1. After removal of piping, conduit, fasteners, and other construction, fill areas in existing concrete and masonry floors, walls, and ceilings with non-shrink grout and finish smooth.
   2. Remove concrete bases for equipment and supports by:
      a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface.
         1) Do not cut existing reinforcement in slab.
      b. Chip concrete within scored lines.
      c. Cut exposed reinforcing steel and anchor bolts that will project above the repaired surface.
      d. Patch with non-shrink grout to match adjacent grade and finish.
   3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.
   4. Where existing fasteners are not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut fasteners flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut fasteners 1 inch below the surface, paint ends with epoxy, and patch holes with epoxy grout.

3.05 FIELD QUALITY CONTROL

A. Do not proceed with demolition without Engineer's inspection of lay out.

B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION

SECTION 01756

COMMISSIONING

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Commissioning.

1.02 DEFINITIONS

A. Commissioning: The process of planning for, testing of, and start-up of systems, subsystems, equipment, components, and devices of the Work to demonstrate, through documented verification, that the Work has successfully met the Contract Documents. It includes training the Owner's staff in the operation and maintenance of the installed Work.

B. Commissioning Phases: The activities of commissioning are grouped into the phases defined in the following table.
   1. Table 1 - Commissioning Phases.

TABLE 1 - COMMISSIONING PHASES		
Planning Phase	**Testing and Training Phase**	**Start-Up Phase**
Draft Test Plans	Source Testing: • Documentation	Start-Up: • Documentation • Owner Training
Owner Training Plan	Installation Verification: • Documentation • Owner Training	
	Functional Testing: • Documentation • Owner Training	

   2. Attachment A provides Commissioning Flowcharts.

C. Component: A part of a system that does not have an electrical connection or internal electronics. Examples: Piping and pressure gauges.

D. Device: A part of a system that has electrical connections or internal electronics. Examples: Level transmitter or pressure transmitter.

E. Electrical Energization Plan: A plan to manage how and when power is applied to electrical equipment.

F. Equipment: A factory or field assembled apparatus that performs an identifiable function. Examples: Pumps, motors, VFDs, MCCs.

G. Functional Testing: Testing performed on a completed subsystem or system to demonstrate that the system meets the specified requirements. Example systems: Backwash system, dewatering system.

H. Installation Verification: Testing to demonstrate that equipment or system and associated components or devices have been properly installed. Example equipment: Pumps, meters, and blowers with associated piping.

I. Manufacturer's Certificate of Functional Compliance: The form completed by the manufacturer to confirm that testing of the installed equipment or system has been performed and the results conform to the specified performance. The form is provided in Attachment D provided at the end of this Section.

J. Manufacturer's Certificate of Installation Verification: The form completed by the manufacturer to confirm that the equipment or system is installed in conformance with the Contract. The form is provided in Attachment C at the end of this Section.

K. Manufacturer's Certificate of Source Testing: The form completed by the manufacturer to confirm that the specified source tests have been performed and the results conform to the specified requirements. The form is provided in Attachment B at the end of this Section.

L. Owner Training: The Owner's staff is trained by the Contractor, with assistance from manufacturer, to operate and maintain the completed Work. This is sometimes referred to as Vendor Specific Training.

M. Process Stream: A series of liquid or solids flow processes that are designed to improve the water quality to meet regulatory permit requirements.

N. Source Testing: Test equipment or products for performance at point of manufacture or assembly for the requirements specified in the Contract Documents. Also referred to as factory testing and factory acceptance testing (FAT).

O. Start-Up: Operating the Work with process water to verify the Work meets the Contract Documents.

P. Start-Up Phase: The phase when Start-Up occurs.

Q. Subsystem: A grouping of equipment, components, and devices that is a part of a larger system and that perform a single definable function. Examples: Sand filters, filter backwash.

R. System: A grouping of equipment, components, and devices that perform a single definable function. If a system is a part of a larger system, it is referred to as a subsystem.
   1. Examples: Flocculation and sedimentation, filtration.

S. System Testing: Testing of a completed system for an extended time period. Examples: Headworks, filtration.

T. Water Management Plan: A plan to manage the test water used for commissioning from source to disposal. The test water may be clean water, potable water, non-potable water, or process water (e.g., raw water, plant water, sludge). The plan demonstrates how water will be produced, conveyed, treated, disposed of as directed by the plant manager, and/or recycled.

1.03 SUBMITTALS

A. Project Commissioning:
   1. Commissioning Coordinator's qualifications.
      a. Submit to Engineer no later than 30 days after Notice to Proceed.
      b. Describe previous similar experience on similar projects with a list of references including phone numbers.
      c. Provide names and qualifications of commissioning assistants, if applicable.
   2. Schedules:
      a. Commissioning Schedule containing all commissioning activities.
      b. Owner Training Schedule.
   3. Test Plans:
      a. Submit draft Test Plan outlined in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Plans required for successful completion of Planning Phase.
      b. Submit final Test Plan a maximum of 90 calendar days prior to testing.
      c. Engineer approval of final Test Plan required prior to start of testing.
   4. Test Reports:
      a. Submit draft Test Reports outline in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Reports outline required for successful completion of Planning Phase.
      b. Submit final Test Report a maximum of 30 calendar days after testing.

B. Technical Sections Commissioning:
   1. Manufacturer's representative's qualifications.
      a. Submit to Engineer no later than 30 days in advance of required services.
      b. Representative's name, phone, and e-mail address:
         1) May use 2 representatives: 1 for field testing and 1 for Owner Training.
         2) Provide resume stating instructor's technical expertise and instructional technology skills and experience.
   2. Test Plans:
      a. Submit draft Test Plan outlined in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Plans required for successful completion of Planning Phase.
      b. Submit final Test Plan a maximum of 90 calendar days prior to testing.
      c. Engineer approval of final Test Plan required prior to start of testing.
   3. Test Reports:
      a. Submit draft Test Reports outline in the Planning Phase, unless specified otherwise.
         1) Engineer approval of draft Test Reports outline required for successful completion of Planning Phase.
      b. Submit final Test Report a maximum of 30 calendar days after testing.
   4. Manufacturer's representatives field notes and data.
   5. Owner Training:
      a. Prior to the training session:
         1) Training instructor qualifications.

2) Training course materials: Due 30 calendar days prior to initial training session.
   a) If Owner requires, Continuing Education Units (CEUs), submit training materials to state regulatory agency in sufficient time to obtain approval for training prior to the training.
   b) Drafts of training agenda, lesson plan, presentation, handouts, and list of audio-visual aids.
   c) Format: 1 electronic copy in the format specified by the Owner and 3 hard copies organized in notebooks.

b. Post training session:
   1) Training course materials: Due 14 calendar days after class completion.
      a) Recordings.
      b) Class attendance sheet.
      c) Final version of training agenda, final lesson plan, presentation, handouts, and audio-visual aids.
      d) Format: 1 electronic copy in the format specified by the Owner and 3 hard copies organized in notebooks.
   2) Provide materials for all sessions of the class in a single transmittal.
   3) If the Owner requires training CEUs, issue training CEU certificates approved by the state regulatory agency to Owner's staff who successfully completed the training.

1.04 COMMISSIONING COORDINATOR (CC)

A. Responsibilities include the following:
   1. Become thoroughly familiar with Contract Commissioning requirements.
   2. Provide the primary interface with Engineer and Owner for Commissioning efforts.
   3. Lead Commissioning efforts - all phases and tasks.
   4. Coordinate training efforts.
   5. Meetings:
      a. CC is responsible for setting Commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
      b. CC shall conduct Commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.
      c. Frequency: Monthly minimum. Increase frequency as needed based on complexity and quantity of Commissioning activities.

B. CC on-site:
   1. Testing and Training Phase: Full-time.
   2. Start-Up Phase: Full-time.

1.05 MANUFACTURER'S REPRESENTATIVES

A. Qualifications: As specified below and in the Technical Sections:
   1. For Installation and Functional Testing:
      a. Factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full

authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.

2. Training instructor qualifications:
    a. Provide resume stating instructor's technical preparation and instructional technology skills and experience.
    b. If CEUs are required, the operator training instructors must comply with state regulatory.
    c. Knowledgeable in the equipment/system for which they are training.
    d. Experienced in conducting classes.
    e. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
3. Representatives to be approved by Owner and Engineer.
4. No substitute representatives without written approval by Owner and Engineer.

B. Duties:
1. Determine if additional time and/or trips (beyond those specified in the Technical Sections) is required to perform the specified services.
2. Coordinate services in accordance with the Contractor's project schedule up to and including making multiple trips to the project site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.
3. Perform on-site services as specified in the Technical Sections.
4. Provide daily copies of manufacturer's representatives field notes and data to Contractor.

1.06 PLANNING PHASE

A. Overview of Planning Phase:
1. Define approach and timing for Commissioning.
2. Obtain Engineer approval of draft Test Plans.

B. Test Plans:
1. Define approach and timing for:
    a. Testing and Training Phases.
        1) Major systems, with separate plans for each system.
    b. Start-Up Phase.
2. Centralized Commissioning database:
    a. Provide system to manage information.
        1) Detailed steps.
        2) Dependencies and other relationships of steps.
    b. Update the database within 24 hours of task completion.
3. Source Test (Factory Acceptance Test) and Functional Test Plans:
    a. As specified in this Section and other Technical Sections.
    b. Based on approved Shop Drawings.
    c. Prepared by the Contractor.
    d. Include the following items for each test:
        1) Purpose of the test.
        2) Identification of each item of equipment/system to be tested, including system designation, location, tag number, control loop identifier, etc.

3) Description of the pass/fail criteria that will be used.
4) Listing of pertinent reference documents (Contract and industry standards or sections applicable to the testing).
a) Credentials of test personnel.
5) Test equipment:
a) Include Product Data for the test equipment.
b) Appropriate calibration records.
(1) Drawings or photographs of test stands and/or test apparatus.
6) Duration: Determine test durations with Owner's input.
7) Detailed step-by-step test procedures.
a) Level of detail shall be sufficient for the witness to follow the steps.

e. Define for Functional Testing:
1) Required temporary systems (pumps, piping, etc.).
2) Shutdown requirements for existing systems.

f. Furnish labor, power, tools, equipment, instruments, and services required for and incidental to testing activities.

4. Test forms minimum requirements:
a. Name of product to be tested.
b. Test date.
c. Names of persons conducting the test.
d. Names of persons witnessing the test, where applicable.
e. Test data.
f. Applicable project requirements as specified in the Technical Sections.
g. Check offs for each completed test or test step.
h. Place for signature of person conducting tests and for the witnessing person, as applicable.

5. Owner responsibilities:
a. Owner will schedule staff within the constraints of their workloads.
1) Those who will participate in this test have existing full-time work assignments, and testing is an additional assigned work task, therefore, scheduling is imperative.
2) Treatment facilities are typically operated on an around-the-clock basis and are staffed in work shifts.
1) Maximum hours per day available for commissioning activities: 4.
2) Days available for commissioning activities: Monday to Thursday.
3) Scheduling coordination with the CC.

6. CC is responsible for the following:
a. Coordinate schedule with the Owner's personnel and manufacturer's representatives (instructors).

C. Test Reports:
1. Minimum requirements:
a. Title.
b. Abstract.
c. Equipment.
d. Procedures.
e. Results.
1) Complete disclosure of the calculation methodologies.
f. Conclusions.

g. Signature by an authorized party.
h. Appendices.
1) Completed test forms signed by witnesses.

2. Water Management Plan:
a. Requirements:
1) Demonstrate how water will be produced, conveyed, treated, recycled, and or disposed until testing verifies specified requirements.

3. Commissioning Schedule:
a. Content:
1) Comply with Attachment G - Functional Testing Requirements and provide activities organized by system and subsystem.
2) Include:
a) Source Testing when required.
b) Functional Testing.
c) Owner Training.
3) Comply with Attachment F - Commissioning Roles and Responsibilities Matrix.
b. Procedures:
1) Submit Commissioning Schedule as specified in Section 01321 - Schedules and Reports.

1.07 TESTING AND TRAINING PHASE

A. Overview of Testing and Training Phase:
1. General:
a. Contractor tests the Work to verify it meets the Contract requirements.
b. Contractor trains the Owner to operate and maintain the Work.
2. Contractor responsibilities:
a. Furnish labor, chemicals, tools, equipment, instruments, and services required for and incidental to completing Commissioning activities in accordance with the approved Commissioning Plans.
3. Owner responsibilities:
a. Furnish labor, chemicals, and services required for and incidental to completing Commissioning activities in accordance with the approved Commissioning Plans.
b. Owner provided services, equipment, and/or materials to be as specified in Section 01110 - Summary of Work.

B. Source Testing:
1. As specified in the Technical Section.
2. Source Test Plan:
a. Engineer approval of Source Test Plan required prior to testing.
3. Witnessed in person:
a. As specified in the Technical Section.
b. Contractor is responsible for trip costs associated with Owner’s and Engineer’s representatives.
1) Transportation:
a) Commercial airline costs to and from SLC, including related fees.
b) Rental car to and from arrival airport, hotel, and test site including related fees.

2) Hotel/Meals:
a) Hotel with an American Automobile Association 3 Diamond rating or higher equivalent for single occupancy room per person per day.
b) Meal allowance based on state government per diem guidelines per test site location.

4. Virtual witness testing:
a. As specified in the Technical Sections.
b. Contractor is responsible for costs associated with virtual witness.
c. Provide the following:
1) An agenda detailing start time of each major phase in the procedure defined in the approved Test Plan.
2) A dedicated operator (separate from the test technician) to operate the camera, provide commentary throughout test, and inspect devices at the request of the attendees.
d. Online meeting platform: Microsoft Teams.
e. Share video through a high-definition camera.
f. Establish methods to communicate, convey, and record information clearly even in environments with loud background noise.
1) Electronic feed for screen sharing of the control panel, HMI, or other screens used throughout testing.
2) Provide recording of virtual sharing within 1 day after testing.
g. Test run of virtual sharing a minimum of 1 week prior to the test:
1) Use current record documents in PDF format.
2) Provide recording of virtual sharing within 1 day after the test run.
3) Engineer approval of test run virtual sharing is required before Source Testing.

5. If the Source Test is not ready on the scheduled date or if the Source Test fails:
a. Contractor is responsible for associated costs:
1) First test costs that are non-refundable, if applicable.
2) Repeat test costs:
a) Trip costs, if applicable.
3) Virtual witness costs, if applicable.
a) Witness labor costs:
(1) Travel time and witness time are included, if applicable.
(2) The greater of $200 per hour or $1,600 per day.

6. Source Testing is complete after successful testing, submittal of test report, and Manufacturer's Certificate of Source Testing.
7. Engineer approval of Source Testing Report is required.

C. Installation Verification:
1. Overview:
a. Verifying the installation of equipment to be in accordance with Manufacturer's Instructions.
2. Prerequisite:
a. Engineer approval of Source Testing Report.
3. Perform checks:
a. Structural anchorage check.
b. Electrical energization check.
1) As specified in the flowchart shown in Attachment A.
c. Health and safety check.

4. Submit Manufacturer's Certificate of Installation Verification.
5. Engineer approval of Manufacturer's Certificate of Installation Verification is required.

D. Functional Testing:
   1. Overview:
      a. Testing the function of a system or subsystem.
   2. Prerequisites:
      a. Engineer approval of Manufacturer's Certificate of Installation Verification.
      b. Engineer approval of Functional Test Plan required prior to testing.
      c. Draft Operations and Maintenance Manual as specified in Section 01782 - Operations and Maintenance Manual.
      d. Completed pipe, valve, and gate labeling of system or subsystem.
         1) As specified in Section 15076 - Pipe Identification prior to the start of Functional Testing.
   3. Witnessed.
   4. Discipline checks:
      a. Verify support systems function properly, such as seal water, pipes, valves, etc.
      b. As specified in the individual Technical Sections.
   5. Instrumentation and controls tests.
      a. Loop Validation Tests.
      b. Complete End-to-End Testing (CEET):
         1) Signal are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
   6. Restore to condition prior to testing:
      a. Remove, clean, and replace permanent and temporary filters and strainers in pipeline systems.
      b. Dewater and clean sumps.
      c. Dewater process units, where required by test plan.
   7. Submit Manufacturer's Certificate of Functional Compliance.
   8. Engineer approval of Manufacturer's Certificate of Functional Compliance is required.

E. Documentation:
   1. Provide records generated during Commissioning Phase of Project, including, but not limited to:
      a. Training documentation.
      b. Manufacturer's Certificate of Source Testing.
      c. Manufacturer's Certificate of Installation Verification.
      d. Manufacturer's Certificate of Functionality Compliance.
      e. Daily logs of equipment/system testing identifying tests conducted and outcome.
      f. Test forms and documentation.
      g. Functional Testing results.
      h. Logs of time spent by manufacturer's representatives performing services on the job site.
      i. Equipment lubrication records.
      j. Electrical phase, voltage, and amperage measurements.
      k. Insulation resistance measurements.
      l. Bearing temperature measurements.

m. Data sheets of control loop testing, including testing and calibration of instrumentation devices and setpoints.
n. Provide: 1 electronic copy in format specified by Owner.
o. Store the data within 24 hours of the test or document creation in the project CM system.
p. Due date: Within 14 calendar days of Substantial Completion.

2. Engineer approval of documentation is required.

F. Owner Training:
1. Train Owner's staff on the operation and maintenance of the equipment/system.
a.
2. Train on each topic of the approved Operation and Maintenance Manual.
a. Include classroom instruction and field demonstration with all necessary tools and test equipment.
3. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).
4. Training outcomes:
a. Owner's staff can safely operate, maintain, and repair the equipment/systems provided as recommended by the manufacturer.
5. Training plan:
a. CC shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 90 calendar days prior to commissioning of equipment/system.
b. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
c. Conduct classroom training at location designated by Owner.
d. Scope and sequence:
1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
2) If multiple classes are needed to meet the training objectives, they shall be included in the training plan.
6. Owner Training Schedule:
a. Schedule Owner's staff training within the constraints of their workloads.
1) Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative.
2) Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.
3) Maximum training hours per week: 16.
4) Days available for training:
a) Tuesday to Friday.
b. Training scheduling coordination:
1) CC is responsible for the following:
a) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).

2) Complete Owner Training no sooner than 15 calendar days prior to Functional Testing of each system.

c. Class logistics:
   1) Delivery time minimum: 2 hours.
   2) Delivery time maximum: 4 hours.
   3) Class agenda:
      a) Refreshment break: One 10-minute break.
      b) Meal break: One 45-minute break, unless otherwise specified.
      c) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.
   4) Schedule specific sessions:
      a) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
      b) At the times requested by the Owner, within the period 7 a.m. to 4 p.m. Tuesday through Friday.
         (1) Times scheduled will be at Owner's discretion.
      c) Owner approval and confirmation required for session schedules.
      d) Provide 1 session for each class unless otherwise noted.

d. Number of students:
   1) Estimated class size maximum: 8 staff.
   2) Engineer will confirm the headcount 1 week prior to the class so that the instructor can provide the correct number of training aids for students.

7. Submittals:
   a. Submit Training Plan Schedule 60 calendar days before the first scheduled training session, including, but not limited to, lesson plans, participant materials, instructor's resumes, and training delivery schedules.
   b. Submit training documentation including the following:
      1) Training plan:
         a) Training modules.
         b) Scope and sequence statement.
         c) Contact information for manufacturer's instructors including name, phone, and e-mail address.
         d) Instructor qualifications.
      2) Training program schedule:
         a) Format: Bar chart:
            (1) Include in the Project Progress Schedule.
         b) Contents:
            (1) Training modules and classes.

8. Lesson plans:
   a. Divide training into discrete modules appropriate for the equipment and trades.
   b. State performance-based learning objectives in terms of what the trainees will be able to do at the end of the lesson.
   c. Define student conditions of performance and criteria for evaluating instructional success.
   d. Minimum requirements:
      1) Hands-on demonstrations planned for the instructions.
      2) Cross-reference training aids.

3) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
4) Attach handouts cross-referenced by section or topic in the lesson plan.
5) Indicate duration of outlined training segments.

e. Provide instruction lesson plans for each trade:
1) Detailed component description:
a) Identify each component function and describe in detail.
b) Identify equipment's mechanical, electrical, and electronic components and features.
c) Where applicable, group relative components into subsystems.
d) Identify and describe in detail equipment safety features, permissive and controls interlocks.
2) Equipment operation:
a) Describe equipment's operating (process) function and system theory.
b) Describe equipment's fundamental operating principles and dynamics.
c) Identify support equipment associated with the operation of subject equipment.
d) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
e) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
f) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.
3) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance).
a) Review preventive maintenance frequency and task analysis table.
4) Define equipment Corrective Maintenance (CM) troubleshooting:
a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.
c) Provide component specific troubleshooting checklists as they relate to specific craft problems.
d) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
e) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
5) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

9. Training instruction format:
    a. Training for operations and maintenance personnel shall be provided as 1 entity.
    b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
    c. Lecturing should be less than 30 percent of class time.
    d. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture to support training objectives.
    e. Conduct hands-on instruction according to the following descriptions:
        1) Present hands-on demonstrations of at least the following tasks:
            a) Proper start-up, shutdown, and normal and alternative operating strategies.
            b) Common corrective maintenance repairs for each group.
            c) Recommended procedures to check/test equipment/system following a corrective maintenance repair.
            d) Preventative maintenance points.
            e) Calibration, if applicable.
        2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
            a) Submit requests for supplemental assistance and facilities with the Contractor's proposed lesson plans.
        3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel.
    f. Training aids:
        1) Instructors shall provide needed audio-visual devices such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, etc., for each class.
        2) Instructor to confirm with Engineer in advance of each class that the classroom will be appropriate for the types of audiovisual equipment to be employed.
10. Training sessions:
    a. Provide training sessions for equipment/system as specified in the individual equipment/system section.
    b. Include the following information in the agenda:
        1) Instructor name.
        2) Listing of subjects to be discussed.
        3) Time estimated for each subject.
        4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
        5) List of documentation to be used or provided to support training.
    c. Owner may request that particular subjects be emphasized, and the agenda be adjusted to accommodate these requests.
    d. Owner may record audio and/or video of training sessions.
    e. Distribute copies of the agenda to each student at the beginning of each training class.
    f. Trainees will keep training materials and documentation after the session.
    g. Distribute Training Evaluation Form following each training session.
        1) Training Evaluation Form is included in this Section.

2) Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
3) Revise training sessions judged "Unsatisfactory" by a majority of attendees.
a) Conduct training sessions again until a satisfactory rating is achieved.

11. Engineer approval of Owner Training is required.

1.08 START-UP PHASE

A. Overview of Start-Up Phase:
1. General:
a. Confirm reliability requirements.
b. Confirm regulatory compliance.
1) Test filters to confirm regulatory compliance with an effluent turbidity of <0.1 NTU at a filtration rate up to 8.8 gpm/sf (with approval of Owner)
2) Test backwash system up to flow rates of 21,000 gpm to 29,600 (with approval of Owner and Engineer).
3) Test air scour system up to flow rates 5,480 scfm (with approval of Owner and Engineer).
4) Test filter-to-waste system up to flow rates of 12,200 to 12,800 gpm (with approval of Owner and Engineer).
5) Test chemical systems over the full operating range of doses (with approval of Owner and Engineer).
6) Test standby power generator and switching (with approval of Owner and Engineer).

B. Start-Up Period (performance test):
1. Contractor responsibilities:
a. Support Owner to operate the Work.
b. Provide necessary craft labor assistance, in the event of an emergency equipment failure requiring immediate attention (emergency is defined as a failure of function which precludes the further operation of a critical segment of or the whole of the Work) with a response time of not more than 4 hours from the time of notification.
c. Provide list of 24-hour "on-call" representative supervisory persons who will monitor the Operational Testing and serve as liaison for the Engineer and Owner.
2. Owner responsibilities:
a. Owner to operate the Work.
b. Owner-provided services, equipment, and/or materials to be as specified in Section 01110 - Summary of Work.
c. Furnish labor, chemicals, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
3. Prerequisites:
a. Engineer approval of Testing and Training Phase.
4. Witnessed.
5. Duration: 7 days unless otherwise indicated. Several facilities, include the Chlorine Building, PEA, PEC, and PC areas require a longer performance

period (14 days) - see Section 01140 - Work Restrictions for specific processes.

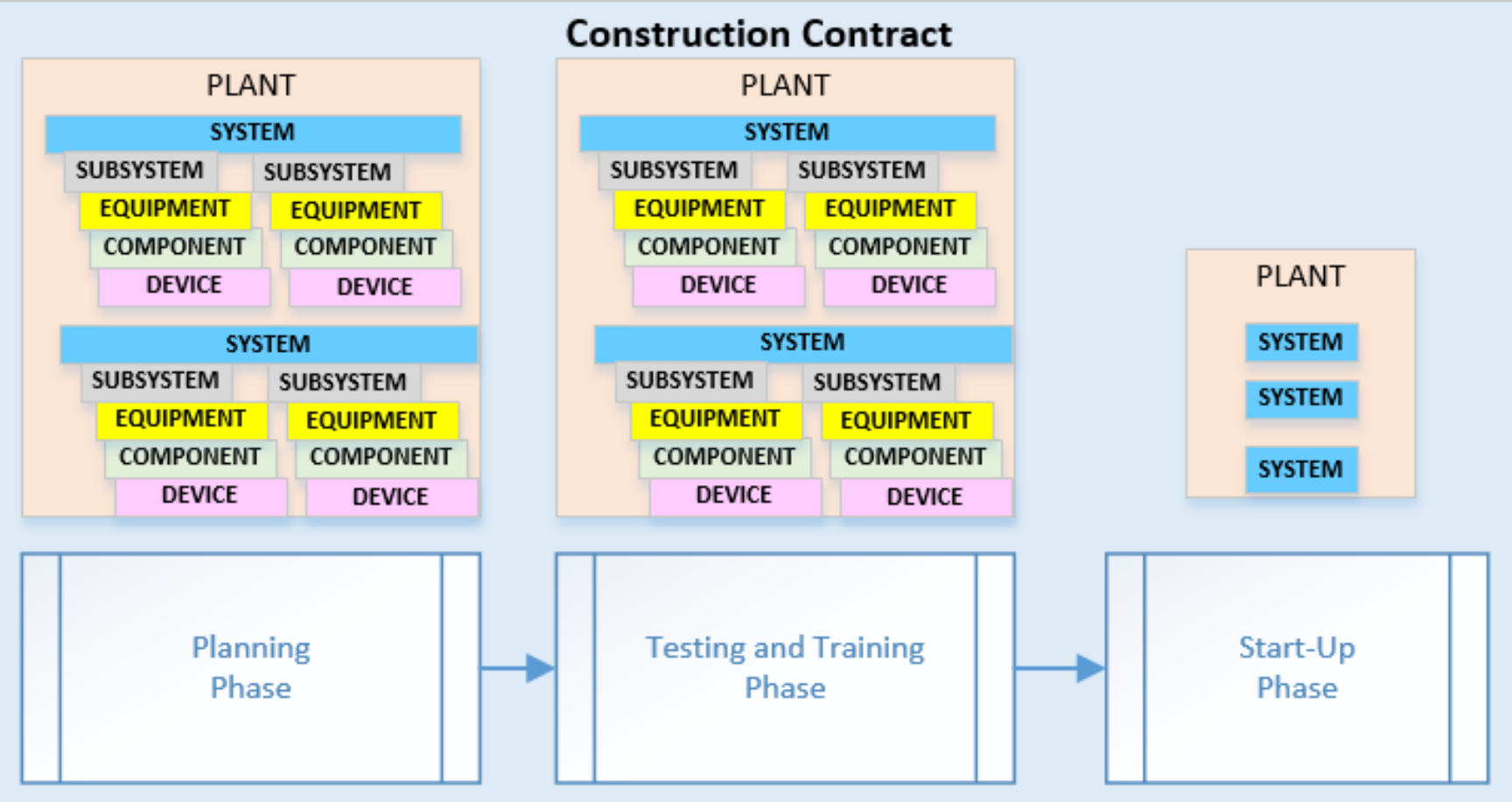
6. Engineer approval of Start-Up Period is required to achieve substantial completion.
7. Operation:
    a. Entire system shall continuously meet performance requirements and shall operate without fault, failure, or defect for a continuous period.
    b. Individual equipment/system failures that are corrected within 24 hours and do not prevent the entire project from continuously satisfying the established operational requirements shall note require the consecutive day test to be restarted unless the failure recurs.
    c. Restart the start-up period for any of the following conditions:
        1) Any failure of the complete Project construction to meet operational requirements.
        2) When malfunctions or deficiency cause shutdown or partial operation of the facility, or results in failure of the complete Project to meet operational requirements.
        3) Any individual equipment/system failure that meets any of the following conditions:
            a) Requires more than 24 hours to correct.
            b) Recurs within the 24-hour correction period requiring further correction.
        4) Immediately correct defects in material, workmanship, or equipment/system which became evident during testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - COMMISSIONING FLOWCHARTS


Construction Contract
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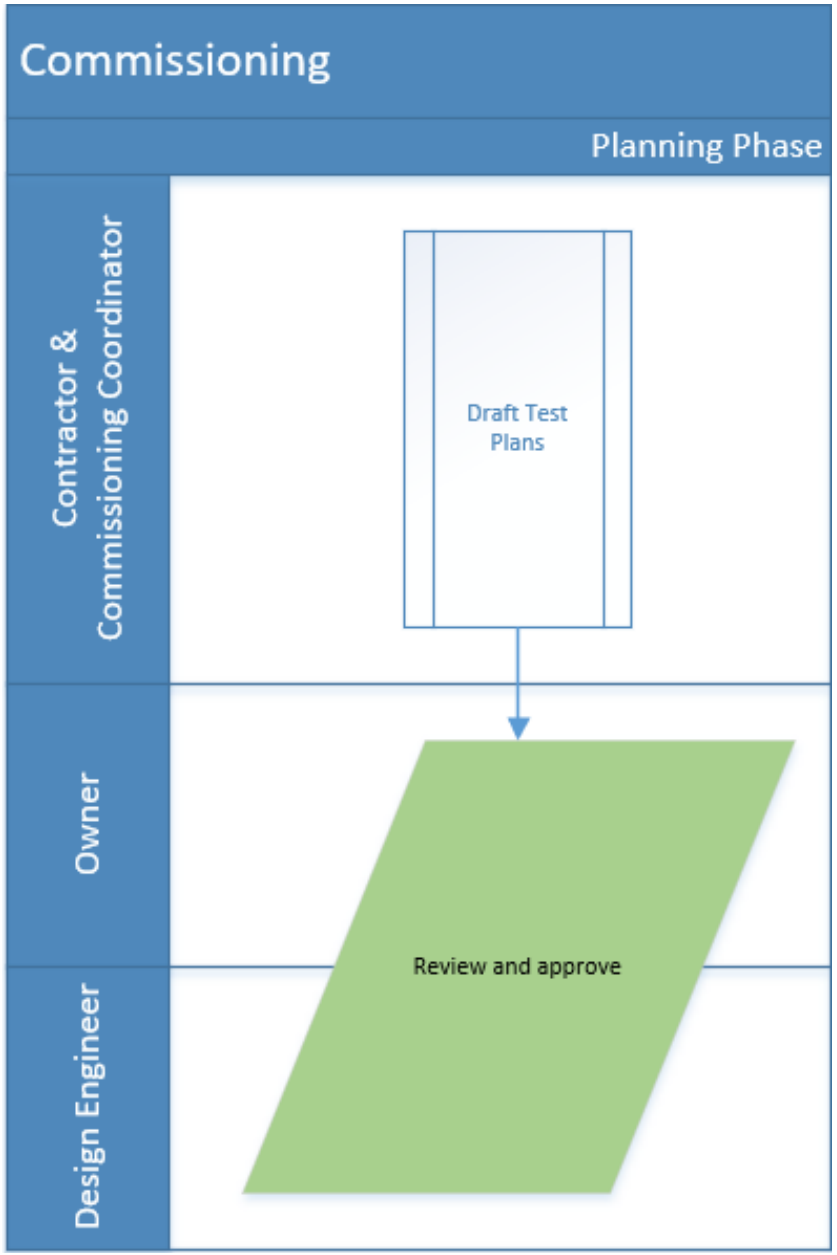
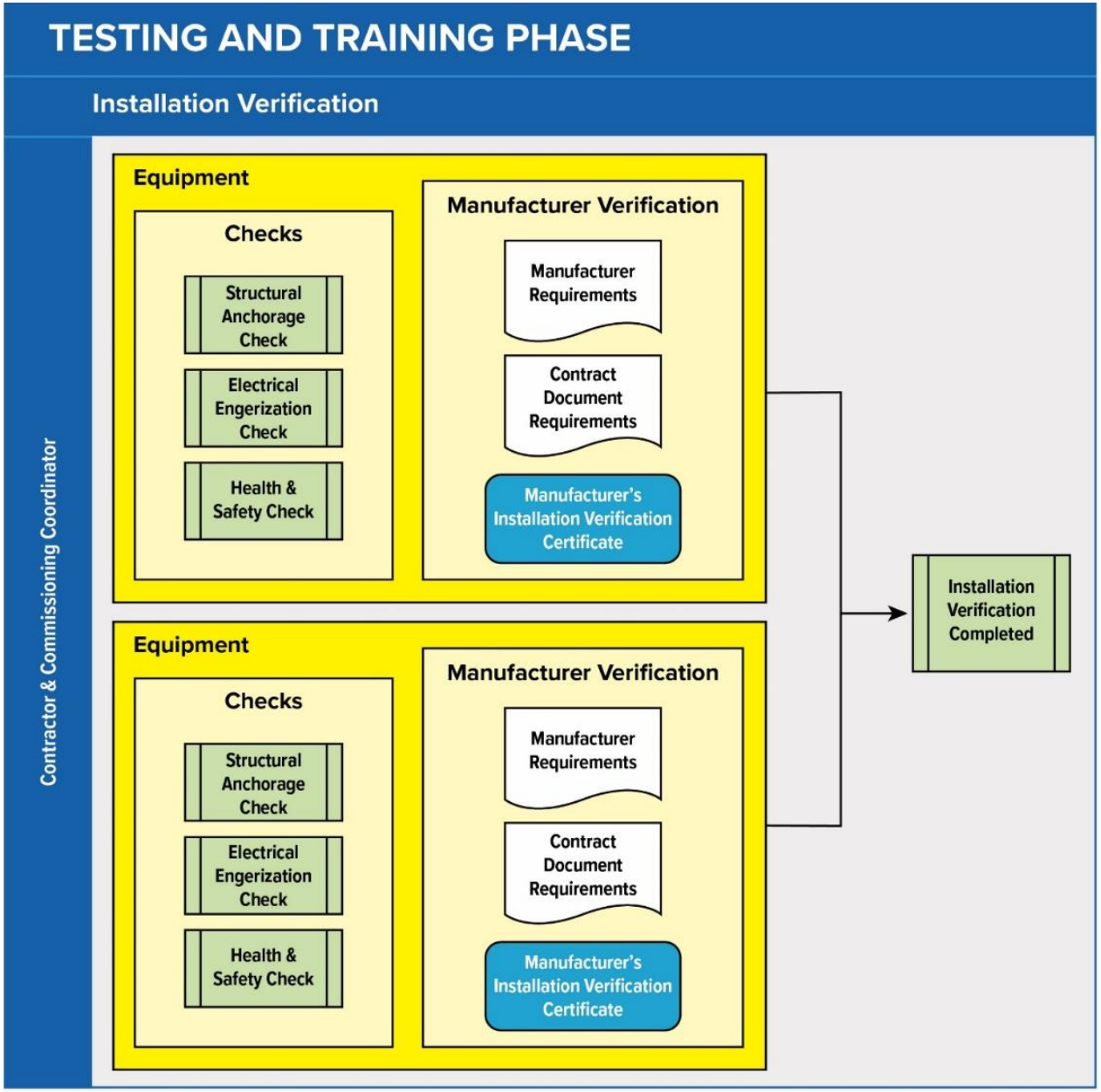
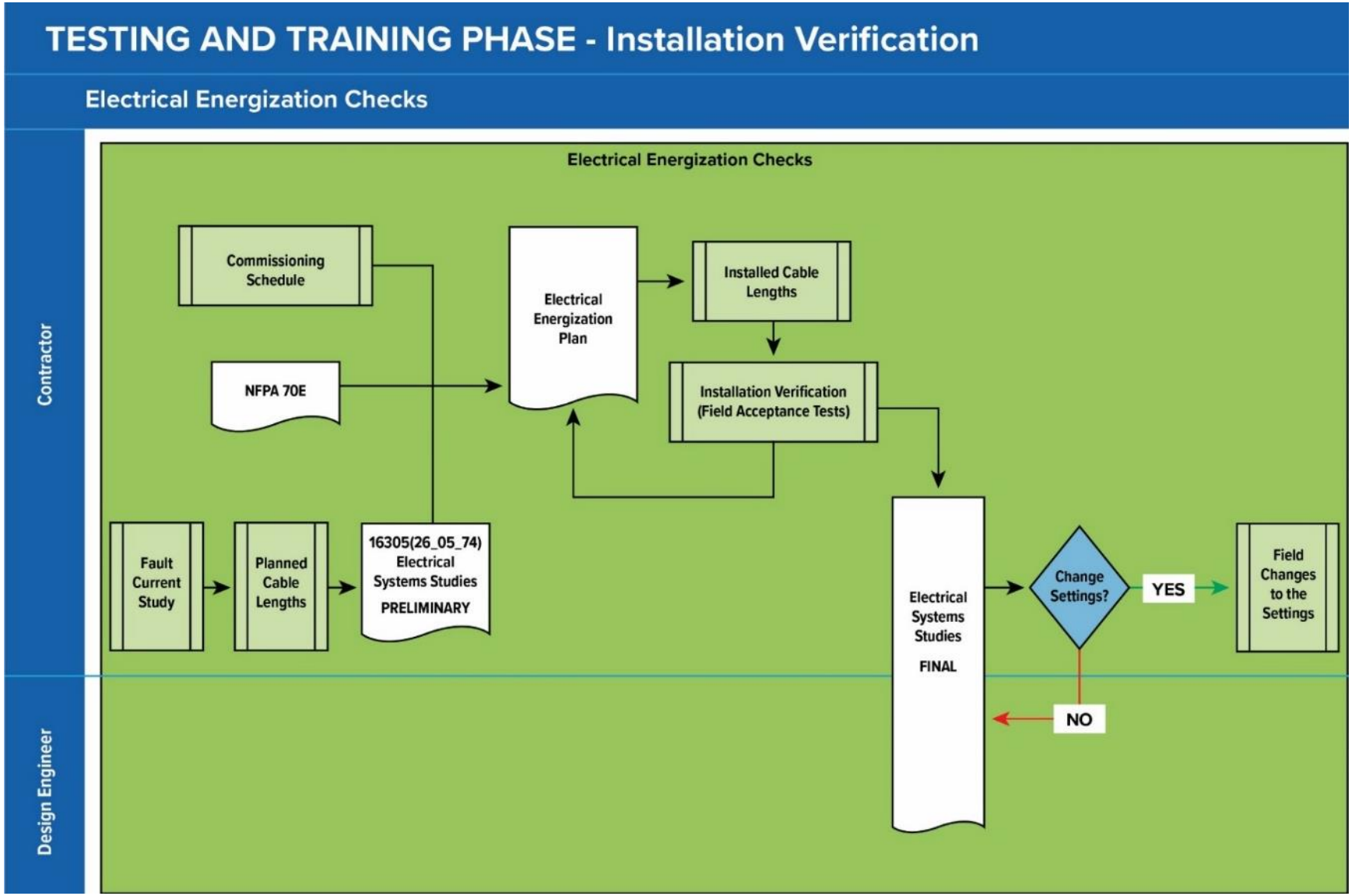
Planning Phase
Testing and Training Phase
Start-Up Phase


Commissioning
Planning Phase
Contractor & Commissioning Coordinator
Draft Test Plans
Owner
Review and approve
Design Engineer


TESTING AND TRAINING PHASE
Installation Verification
Contractor & Commissioning Coordinator
Equipment
Checks
Structural Anchorage Check
Electrical Engerization Check
Health & Safety Check
Manufacturer Verification
Manufacturer Requirements
Contract Document Requirements
Manufacturer's Installation Verification Certificate
Equipment
Checks
Structural Anchorage Check
Electrical Engerization Check
Health & Safety Check
Manufacturer Verification
Manufacturer Requirements
Contract Document Requirements
Manufacturer's Installation Verification Certificate
Installation Verification Completed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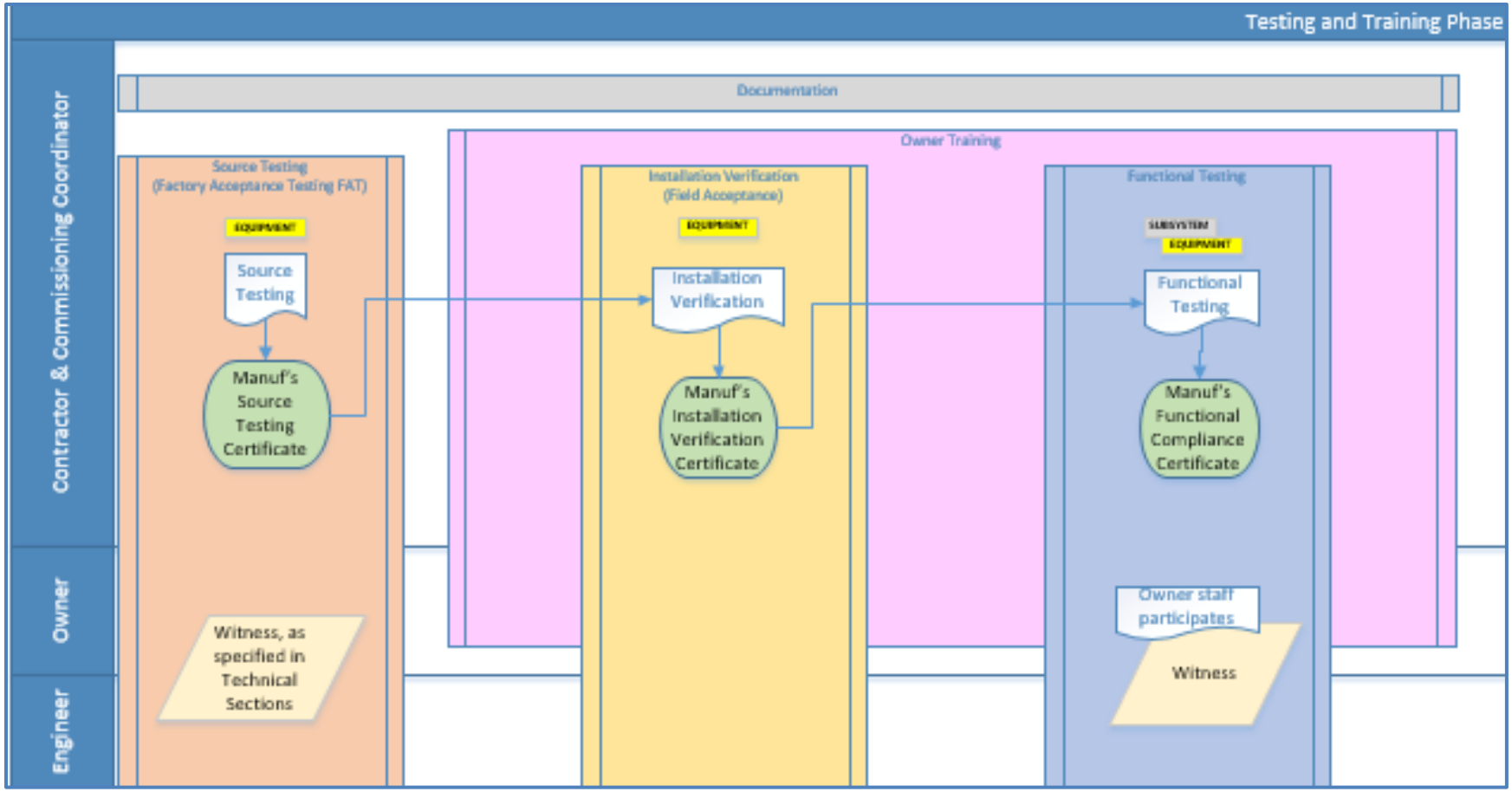
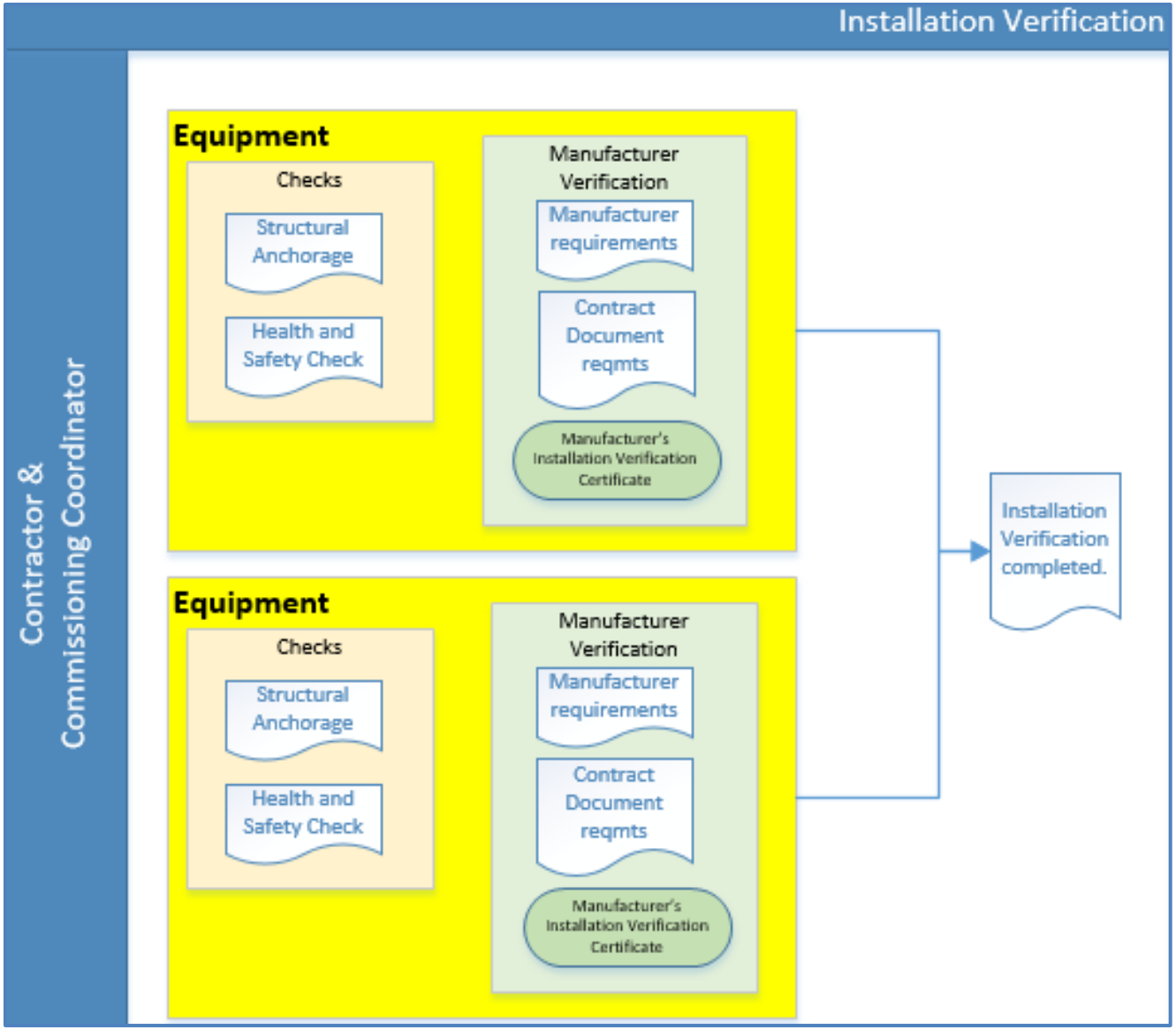
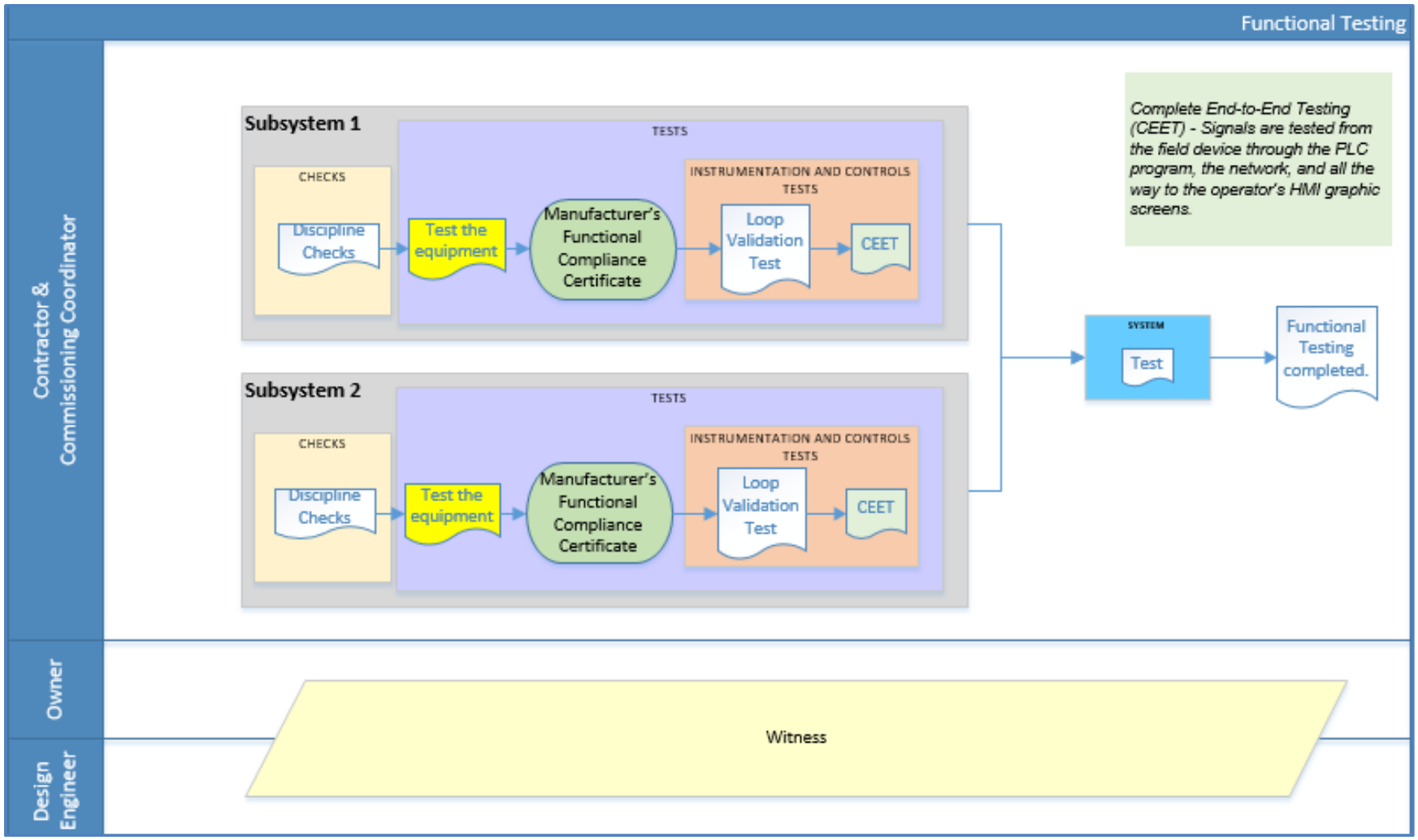
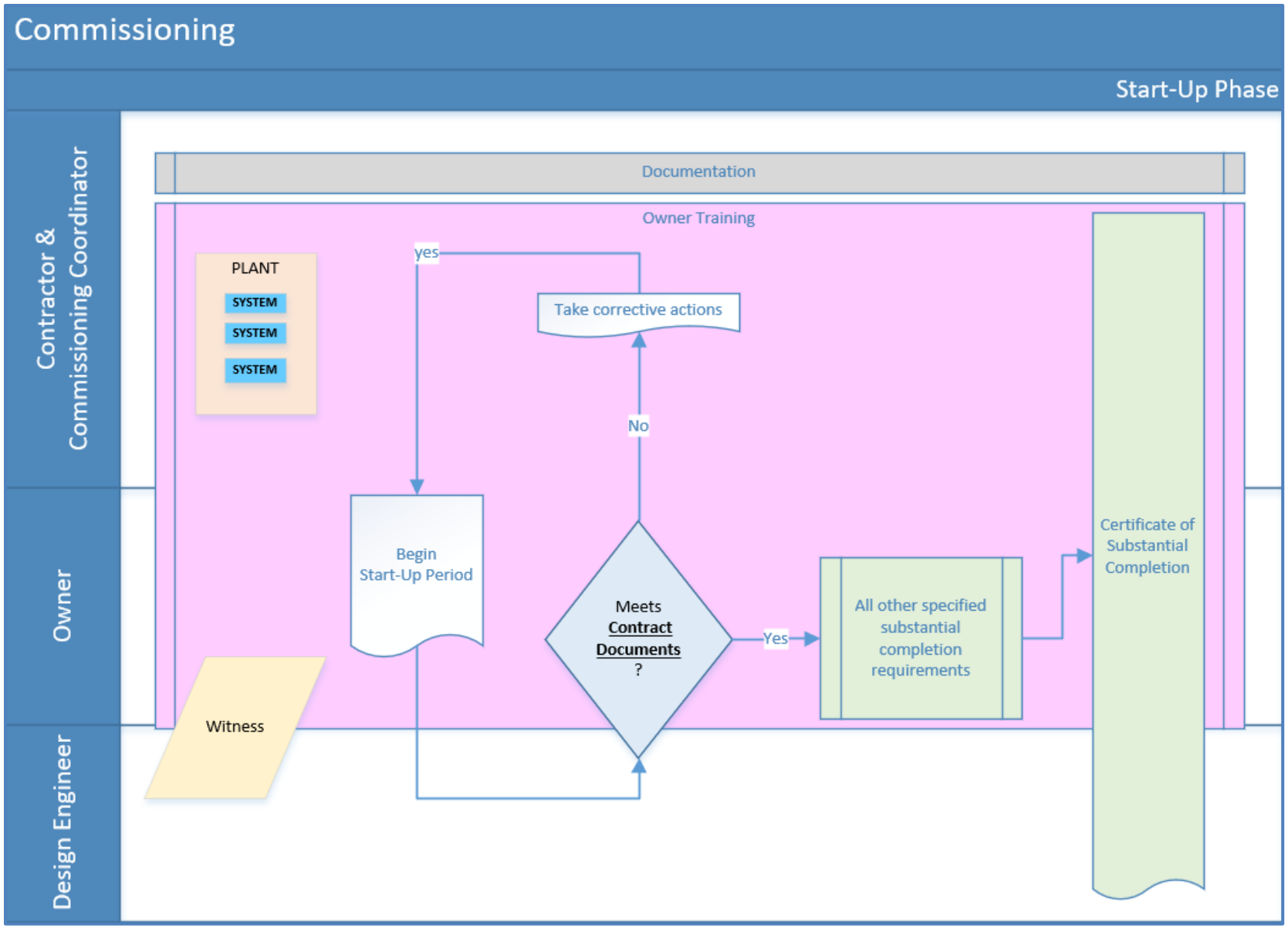
Electrical Energization Checks
Contractor
Design Engineer
Electrical Energization Checks
Commissioning Schedule
NFPA 70E
Electrical Energization Plan
Installed Cable Lengths
Installation Verification (Field Acceptance Tests)
Fault Current Study
Planned Cable Lengths
16305(26_05_74) Electrical Systems Studies PRELIMINARY
Electrical Systems Studies FINAL
Change Settings?
YES
NO
Field Changes to the Settings


Testing and Training Phase
Contractor & Commissioning Coordinator
Owner
Engineer
Documentation
Owner Training
Source Testing
(Factory Acceptance Testing FAT)
EQUIPMENT
Source Testing
Manuf's Source Testing Certificate
Witness, as specified in Technical Sections
Installation Verification
(Field Acceptance)
EQUIPMENT
Installation Verification
Manuf's Installation Verification Certificate
Functional Testing
SUBSYSTEM
EQUIPMENT
Functional Testing
Manuf's Functional Compliance Certificate
Owner staff participates
Witness


Installation Verification
Contractor & Commissioning Coordinator
Equipment
Checks
Structural Anchorage
Health and Safety Check
Manufacturer Verification
Manufacturer requirements
Contract Document reqmts
Manufacturer's Installation Verification Certificate
Equipment
Checks
Structural Anchorage
Health and Safety Check
Manufacturer Verification
Manufacturer requirements
Contract Document reqmts
Manufacturer's Installation Verification Certificate
Installation Verification completed.


Functional Testing
Contractor & Commissioning Coordinator
Subsystem 1
TESTS
CHECKS
Discipline Checks
Test the equipment
Manufacturer's Functional Compliance Certificate
INSTRUMENTATION AND CONTROLS TESTS
Loop Validation Test
CEET
Subsystem 2
TESTS
CHECKS
Discipline Checks
Test the equipment
Manufacturer's Functional Compliance Certificate
INSTRUMENTATION AND CONTROLS TESTS
Loop Validation Test
CEET
Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator's HMI graphic screens.
SYSTEM
Test
Functional Testing completed.
Owner
Witness
Design Engineer


Commissioning
Start-Up Phase
Contractor & Commissioning Coordinator
Owner
Design Engineer
Documentation
Owner Training
PLANT
SYSTEM
SYSTEM
SYSTEM
yes
Take corrective actions
No
Begin Start-Up Period
Meets Contract Documents ?
Yes
All other specified substantial completion requirements
Certificate of Substantial Completion
Witness

ATTACHMENT B - MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____

PROJECT NAME _____ EQPT TAG NO. _____

PROJECT NO. _____ EQPT SERIAL NO. _____

SPECIFICATION NO. _____

SPECIFICATION TITLE _____

Comments: _____

_____

_____

_____

_____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20 ____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

_____

(Authorized Signature)

If applicable, Witness Name *(print)*: _____

_____

(Witness Signature)

ATTACHMENT C - MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

OWNER _____ EQPT/SYSTEM _____

PROJECT NAME _____ EQPT TAG NO. _____

PROJECT NO. _____ EQPT SERIAL NO. _____

SPECIFICATION NO. _____

SPECIFICATION TITLE _____

I hereby certify the installation of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

1. Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

ATTACHMENT D - MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

OWNER _____ EQPT/SYSTEM _____

PROJECT NAME _____ EQPT TAG NO. _____

PROJECT NO. _____ EQPT SERIAL NO. _____

SPECIFICATION NO. _____

SPECIFICATION TITLE _____

I hereby certify the Functional Testing of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

1. Attach test results with collected data and test report.
2. Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

WITNESSES:

By Owner's Authorized Representative: _____

(Authorized Signature)

By Engineer's Authorized Representative: _____

(Authorized Signature)

ATTACHMENT E - TRAINING EVALUATION FORM

TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: _____

VENDOR/MANUFACTURER: _____

DATE: _____ NAME OF REPRESENTATIVE: _____

1.	Was representative prepared?	Acceptable	Unacceptable	or	N/A
2.	Was an overview description presented?	Acceptable	Unacceptable	or	N/A
3.	Were specific details presented for system components?	Acceptable	Unacceptable	or	N/A
4.	Were alarm and shutdown conditions clearly presented?	Acceptable	Unacceptable	or	N/A
5.	Were step-by-step procedures for starting, stopping, and troubleshooting presented?	Acceptable	Unacceptable	or	N/A
6.	Were routine/preventative maintenance items clearly identified?	Acceptable	Unacceptable	or	N/A
7.	Was the lubrication schedule (if any) discussed?	Acceptable	Unacceptable	or	N/A
8.	Was the representative able to answer all questions?	Acceptable	Unacceptable	or	N/A
9.	Did the representative agree to research and answer unanswered questions?	Acceptable	Unacceptable	or	N/A

10. Comments: _____

_____

_____

_____

11. Overall Rating Satisfactory Unsatisfactory

Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

ATTACHMENT F - COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Testing and Training Phase				
Source Testing				
	Source Testing	Non-Witnessed	Lead	Witness, Review
	Manufacturer's Certificate of Source Testing	No Action	Lead	Review
Installation Verification				
	Structural Anchorage Check	Witness	Lead	Review
	Health and Safety Check	Witness	Lead	Review
	Manufacturer Requirements Verification	No Action	Lead	Review
	Contract Documents Verification	No Action	Lead	Review
	Manufacturer's Certificate of Installation Verification	No Action	Lead	Review
Functional Testing				
	Checks	Witness	Lead	Witness, Review
	Tests	Witness	Lead	Witness, Review
	Manufacturer's Certificate of Functional Compliance	No Action	Lead	Witness, Review
System Testing				
	System Testing	Witness	Lead	Witness, Review
Start-Up Phase				
	Start-Up	Lead	Support	Witness, Review

Legend:

Lead: Primarily responsible for organization, coordination, and execution of task work product or result.
Support: Assist the lead with organization, coordination, and execution of task work product or result.
Witness: Observe and document completion of task work product or result.
No Action: Limited or no involvement.
Review: Approve for compliance with Contract Documents or reject.

SECTION 01757

DISINFECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cleaning and disinfection requirements for new and existing facilities affected by the Work.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C651 - Disinfecting Water Mains.
   2. C652 - Disinfection of Water Storage Facilities.
   3. C653 - Disinfection of Water Treatment Plants.
   4. C655 - Field Dechlorination.

B. U.S. Environmental Protection Agency (EPA):
   1. Safe Drinking Water Act (SDWA).

1.03 SUBMITTALS

A. Submit disinfection test plan, which details procedure to be utilized to disinfect the facilities, including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of flushing and location of flushing ports (as appropriate for method of chlorination).
   4. Method of dechlorination (as appropriate for method of chlorination).
   5. Disposal location for chlorinated water (as appropriate for method of chlorination).

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Treatment subcontractor’s name, address, and phone number.
   4. Type and form of disinfectant used.
   5. Time and date of disinfectant injection start.
   6. Time and date of disinfectant injection completion.
   7. Test locations.
   8. Initial and 24-hour disinfectant residuals in milligrams per liter for each outlet tested.
   9. Time and date of flushing start.
   10. Time and date of flushing completion.
   11. Disinfectant residual after flushing in milligrams per liter for each outlet tested.

C. Submit bacteriological reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Laboratory name, certification number, address, and phone number.
   4. Time and date of water sample collection.
   5. Name of person collecting samples.
   6. Test locations.
   7. Time and date of laboratory test start.
   8. Coliform bacteria test results for each outlet tested.
   9. Certification that water conforms or fails to conform to bacterial standards of SDWA.
   10. Bacteriologist's signature and bacteriological laboratory's evidence of certification.

D. Submit required permits, including, but not limited to, permit clearance.
   1. Coordinate with Owner and Engineer to obtain any necessary signatures.

1.04 QUALITY ASSURANCE

A. Bacteriological and physical chemistry laboratory: Certified by state in which Project is located.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect chlorine and bacteriological samples against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 degrees Fahrenheit and 80 degrees Fahrenheit.

1.06 PROTECTION

A. Provide necessary signs, barricades, and notices to prevent persons from accidentally consuming water or disturbing system being treated.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disinfectant: Free chlorine in liquid, powder, tablet, or gas form in accordance with AWWA C653.

B. Dechlorination agent: Sulfur dioxide, sodium bisulfate, sodium sulfite, or sodium thiosulfate in accordance with AWWA C655.

PART 3 EXECUTION

3.01 DISINFECTION OF WATER TREATMENT PLANTS

A. Perform disinfection of water treatment plants in accordance with AWWA C653 and as specified in this Section.

B. Complete hydrostatic/leakage tests prior to disinfection.

C. Clean newly constructed and/or modified facilities, including filters and conveyance facilities, such as pipes and channels at the plant, in accordance with AWWA C653 and the following:
   1. Remove debris and material not associated with the structure or process prior to disinfection.
   2. Clean wall, floor, ceiling, and attached surfaces by use of high-pressure water jet, sweeping, scrubbing, or equally effective means.
   3. Remove water, paint flakes, sediment, dirt, and foreign material accumulated during cleaning.
   4. Remove by flushing or other means, soil and debris from water pipes and channels in accordance with AWWA C651.
   5. Protect surfaces from adverse environmental exposure between the preliminary cleaning and the disinfection stages.

D. Prior to chlorination, clean newly constructed and/or modified facilities to be disinfected in accordance with AWWA C651, C652, or C653, as applicable.

E. Provide necessary blind flanges, hoses, sample taps, or any other appurtenances that may be required to clean and disinfect the piping and wetted surfaces.

F. System treatment:
   1. Start disinfection when conditions are satisfactory.
   2. Perform disinfection of water lines and structures in accordance with AWWA C651, C652, and C653, and as specified in this Section.
   3. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.
   4. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:
      a. Ends of piping runs.
      b. Remote outlets.
      c. Tanks.
      d. At least 2 outlets on each building floor where directed.
      e. Drain lines.
      f. Filters and effluent channels and piping.
   5. Maintain disinfectant in system for appropriate 6-hour or 24-hour interval in accordance with AWWA C652.
   6. When disinfectant residual is less than 10 milligrams per liter after 24 hours, repeat system treatment.

7. Stainless steel piping:
    a. Modify procedures for disinfection of stainless steel piping and appurtenances as necessary to avoid causing corrosion, pitting, or attack of stainless steel materials.
        1) Take steps to eliminate chlorinated water trapped in crevices and under gaskets through the following procedures:
            a) Pressurize stainless steel piping systems so that gaskets and O-rings are seated before introducing chlorinated water into the system.
            b) Flush to displace a minimum of 3 pipe volumes at the conclusion of the disinfection procedure.
    b. Use the continuous-feed method to fill the stainless steel piping system with the minimum chlorine concentration required to provide a 10 milligrams per liter residual after 24 hours of contact time in accordance with AWWA C651.

3.02 SURFACES TO BE DISINFECTED

A. Disinfect the following:
    1. Interior surfaces of the filters, basins, filter channels, etc., including the ceilings.
    2. Water storage reservoirs and backwash supply tanks.
    3. Wetted surfaces associated with conveyance elements, such as pipes and channels downstream of the filters, basins.
    4. Any existing wetted surface downstream of the filters, basins that may have been contaminated during the construction process, including backwash supply piping and filter to waste piping to the air gap at the filter to waste MH.
    5. Disinfect wetted surfaces, underdrain equipment, filter media, and submerged accessories associated with the filters:
        a. Before the filter media is placed in service, disinfect the entire filter by chlorination.
        b. Allow a minimum of 24 hours for disinfection of a filter.
    6. After the filter sand and anthracite layers have been brought to the specified gradation and thickness, disinfect each filter as follows:
        a. Inject sufficient chlorine into the washwater to produce a solution having a chlorine concentration of at least 25 milligrams per liter throughout the filter.
            1) Introduce sufficient washwater so that surfaces up to the maximum operating level of the filter will be in contact with the chlorinated water.
            2) Hold the chlorinated water for a minimum of 12 hours.
        b. As an alternative disinfection method, spray surfaces of the filter box up to the maximum operating level with a solution containing 200 milligrams per liter chlorine.
            1) Keep the solution in contact with the surfaces for a minimum of 30 minutes.
            2) Disinfect the remaining portion of the filter with a 25 milligrams per liter chlorine solution for a minimum of 12 hours.
        c. Provide chlorine required for disinfection.
        d. Direct the chlorinated water from disinfection operations to the recycle basins or washwater ponds, as directed by the Owner or Engineer.
    7. Piping systems that are used to convey water, solutions, or chemicals to facilities downstream of filtration or that carry potable water.

3.03 DISINFECTION OF WATER MAINS

A. Perform disinfection in accordance with AWWA C651 and as specified in this Section.

B. Cleaning:
   1. Remove, by flushing or other means, soil and debris from the water tanks in accordance with AWWA C652 prior to chlorination.

C. Inspection:
   1. Verify that water system is completed and cleaned of soil and debris prior to chlorination.

3.04 DISINFECTION OF WATER STORAGE FACILITIES

A. Perform disinfection in accordance with AWWA C652 and as specified in this Section.

B. Test for disinfectant residual at locations as specified in the disinfection test plan:
   1. Inlet and outlet piping.
   2. Drain line.

C. Maintain disinfectant in system for appropriate 6-hour or 24-hour interval in accordance with AWWA C652.

D. When disinfectant residual is less than 2 parts per million after 24 hours, repeat system treatment.

3.05 REPAIRS OR CONNECTIONS TO EXISTING LINES

A. Perform disinfection in accordance with AWWA C651 and as specified in this Section.

B. Clean and sterilize the interior surfaces of new piping, fittings, equipment, and appurtenances to be installed in an existing potable water system or connected to an existing system.

C. Clean and sterilize the existing pipe or facilities for a minimum distance of 3 pipe diameters back from the ends of the pipe. Plug the ends of the line when work is not being performed on the pipe.

D. Perform sterilization by swabbing each item with a concentrated chlorine solution.
   1. Each piece is to be disinfected prior to being assembled for installation in the existing pipe.
   2. Disinfect each piece just prior to assembly to help prevent recontamination.
   3. Plug the ends of the assembly until a new item is to be added to the assembly.
   4. Store disinfected materials on blocks to prevent contact with the ground.

3.06 FLUSHING

A. Remove disinfection water from the facilities as appropriate for the type of disinfectant and method used for disinfection.

B. Flush facilities with potable water containing no more disinfectant residual than the active distribution system or 1.0 milligrams per liter, whichever is greater (as appropriate for method of chlorination).

C. Continue flushing until water at designated flushing ports contains disinfectant residual equal to concentration specified above.

3.07 DISPOSAL OF CHLORINATED WATER

A. Dispose in accordance with AWWA C655 and as specified in this Section.

B. Dispose of chlorinated water in accordance with the submitted disinfection test plan and applicable requirements of federal, state, county, and city having jurisdiction over disposal of hazardous wastes in location of the Project and disposal site.

C. Chlorinated water may only be disposed of in a sanitary sewer system with the written permission of the Owner. If allowed, discharge the chlorinated water at a low rate so it does not surcharge the sewer line.

3.08 BACTERIOLOGICAL TEST

A. Instruct bacteriological laboratory to collect water samples no sooner than 24 hours after start of disinfection of each facility.

B. A minimum of 24 hours after flushing system and within 24 hours before the water main is placed in service, collect bacteriological quality samples at each of following locations and other locations in accordance with the submitted disinfection test plan and Standard Methods for the Examination of Water and Wastewater:
   1. Where water enters system.
   2. Inlet piping.
   3. Ends of piping runs.
   4. Drain lines.
   5. Remote outlets.
   6. Tanks.
   7. At least 2 outlets on each building floor.

C. Analyze water samples in accordance with Standard Methods for Examination of Water and Wastewater.

D. When bacteriological test proves water quality to be unacceptable, repeat disinfection treatment process until water meets quality standards for disinfection.

END OF SECTION

SECTION 01759

WATER LEAKAGE TEST FOR CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Hydrostatic leakage test for concrete water-holding structures.

1.02 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Containment structure, lined: Liquid-containing structure with barrier coating or membrane applied to the inside surfaces to prevent leaking of contents to the outside.
   2. Containment structure, unlined: Liquid containing structure where only the concrete structure itself is used to prevent leaking of contents to the outside.
   3. Damp spots: Surfaces where visible moisture can be picked up by a dry hand.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination.

B. Pre-installation meetings.

C. Sequencing.

D. Scheduling.

1.04 SUBMITTALS

A. Product data.

B. Shop Drawings:
   1. Description and details of each evaporation/precipitation-measuring device anticipated for use during the test.

C. Samples.

D. Certificates.

E. Delegated Design Submittals.

F. Tests and evaluation reports:
   1. Results of water leakage test for each structure and for each portion of a structure designated for testing.

G. Manufacturer instructions.

H. Source quality control submittals.

I. Field/site quality control submittals.

J. Manufacturer reports.

K. Sustainable design submittals.

L. Special procedure submittals:
   1. Testing plan for each structure, or portion thereof, required to be tested.
      a. Describe methods of obtaining water for testing and of releasing water for disposal, including provisions for dechlorination if required.
      b. Include plans showing locations where measurements will be made and locations of evaporation/precipitation-measuring device.
      c. Indicate plans for filling and draining structure(s).
      d. Include schedule showing duration of test for each structure or cell to be tested, date and time for start of each test, dates and times of observations and measurements during the test, dates and times for closeout of testing procedures, and date for submittal of final results.
   2. Proposed procedures and products for repair of leaks.

M. Qualifications statements.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Test structures and portions of structures listed in the following paragraphs for water leakage.
   1. Unless otherwise specified:
      a. Obtain required permits for discharging testing water.
      b. Provide dechlorination of such water if required by the permits.
      c. Prepare and fill the structures.
      d. Provide access and equipment required for testing and for recording test results.
      e. Take measurements and make observations required for testing.
   2. At all times during testing, the Engineer shall have access to observe measurements by others or to make independent measurements.

B. Test the following concrete structures for water leakage:
   1. Backwash Tank.

C. Required preparation for testing is designated in this Section. Waiver of, or failure to complete preparations shall not change the testing criteria or approval criteria for the areas tested.

D. Retest structures and portions of structures until the evaluation criteria are satisfied.

3.02 TEST WATER SOURCE AND DISPOSAL

A. Water used for the first filling of the tank will be furnished by the Owner.
   1. Obtain water for leakage testing from onsite water supplies.

B. In the event that retesting is required, Contractor shall bear the cost of refilling the tank for subsequent tests.

C. After leakage testing is complete, Contractor shall dispose of water by discharging de-chlorinated water to the stormwater system, in compliance with the Contractors construction discharge permit.

3.03 PREPARATION

A. For each structure to be tested, prepare and submit a plan showing schedule and sequence of activities, method of filling, and methods of disposing of test water.

B. Sequencing requirements:
   1. Complete construction of concrete structure and cure concrete to obtain minimum specified 28-day compressive strength as specified in Section 03300 - Cast-in-Place Concrete.
      a. Do not begin tests until all portions of structure are complete and have reached their minimum specified 28-day compressive strength.
      b. Do not begin tests until at least 14 days have passed since completion of the last concrete placement.
   2. Complete tests before:
      a. Covering any surface of the structure with materials that might mask the location of leaks or obscure damp concrete surfaces. Such coverings include, but are not limited to, basin bottom grout, masonry veneer, stucco, plaster, and other coatings.
      b. Installation of equipment, unless otherwise approved by the Engineer.
      c. Backfilling structures to elevations above the limits indicated in the following paragraphs.
   3. Liners and coatings:
      a. Install liners that are mechanically locked to the concrete surface during placement of plastic concrete and before leakage testing.
         1) Examine liners for pinholes, tears, and partially fused splices, complete required liner integrity testing, and make required repairs before commencing leakage testing.
      b. Unless otherwise specified, do not install surface-applied protective or decorative coatings and linings until leakage tests have been completed.

C. Weather requirements:
   1. Tests on structures with tops open to the atmosphere shall not be scheduled for periods when the 10-day weather forecast indicates a substantial change in weather patterns.
   2. Measurements of water surface levels in the structure shall not be scheduled for periods when the weather forecast indicates a difference of more than

35 degrees Fahrenheit between the ambient temperature readings at the times of initial and final measurements.

3. Tests shall not be scheduled for periods when the 10-day weather forecast indicates that the water surface may freeze before the test is complete.

D. Clean interior of structure:
   1. Remove dirt, contaminants, and construction debris.
   2. Flush floors and sumps to provide clean surfaces.
   3. Remove standing water that would interfere with examination of surfaces, cracks, or joints.

E. Disinfect interior of structures as specified in Section 01757 - Disinfection.

F. Observe the structure, or portions of the structure being tested, for potential leak locations:
   1. Give particular attention to cracks, open joints, voids, and honeycombed and repaired surfaces.
   2. Visually observe openings, fitting, and pipe penetrations in the structure at both faces, if possible.
   3. Repair potential leak locations in accordance with these Specifications and as approved by the Engineer.
   4. Backfill excavations to the top of the structure foundation. Do not place backfill against water-bearing walls or over footings unless approved in advance by the Engineer.
      a. If requesting backfilling of walls before testing, include a description of methods that will be used to detect leakage in the backfilled areas.
      b. Engineer's approval of backfilling before testing shall not relieve the Contractor of the responsibility to conduct leakage tests, to satisfy the leakage acceptance criteria for the structure, or to repair leaking portions of the structure, including those portions below or behind the backfill.
   5. See Drawings and Section 02300 - Earthwork for requirements to provide wall stability before backfilling.

G. Inlets to/outlets from the structure:
   1. Make inlets to and outlets from the structure watertight.
      a. Include valves; stop, sluice, and slide gates; and temporary bulkheads as required.
      b. Inlets and outlets not required to be operable may be temporarily sealed before testing of the compartments to which they open.
      c. Secure inlets used to fill the structure for testing to ensure that no water is entering or leaving the structure once it has been filled to the test level.
   2. Adjustments to measured leakage at inlets and outlets based on the manufacturer's or Contractor's estimates will not be allowed.
      a. May be permitted by the Engineer, and, at his/her discretion, only when the Contractor makes specific measurements of leakage at each individual inlet and outlet using methods approved by the Engineer.

3.04 HYDROSTATIC LEAKAGE TEST FOR OPEN OR COVERED CONTAINMENT STRUCTURES ("HST-100")

A. Isolate sections of water-holding structures that can be isolated in actual operation. Fill and test sections for leakage separately.
   1. Fill structures and sections of structures scheduled for testing to 1 inch below any fixed overflow level in covered structures.

B. Initial rate for filling of structures shall not exceed 4 feet per hour.

C. HST-100 testing includes 2 parts, "Qualitative Testing," and "Quantitative Testing," as described in the following paragraphs:
   1. HST-100, Part 1 - Qualitative Testing:
      a. During the first 24 hours after structures are filled, examine exposed concrete surfaces for damp spots or flowing water.
         1) Make observations in early morning, at midday, and in late afternoon.
         2) Continue observations through the duration of the Quantitative Testing period.
         3) Pay particular attention to conditions at joints, honeycombed areas, cracks, and repaired portions of the structure.
      b. Evaluation criteria:
         1) Structure shall be considered to have failed these Qualitative Testing requirements if any of the following conditions are observed.
            a) Water droplets or moist areas on an outside surface that could only have originated inside the structure.
            b) Water is flowing or seeping from joints, cracks, or surfaces.
               (1) Exception: Dampness or wetness on top of a footing, in the absence of flowing water, shall not be considered as failure to meet this criterion.
            c) Moisture can be transferred to a dry hand from the outside surfaces of the filled area.
      c. Repairs and retesting:
         1) Where damp spots or flowing water as described in the preceding paragraphs are observed, mark locations, provide repairs, and retest the structure as specified in subsequent paragraphs.
   2. HST-100 - Part 2: Quantitative Testing:
      a. If approved by the Engineer, Quantitative Testing may begin before repairs are made to areas failing Part 1 of this test; however:
         1) Adjustments to volume loss calculations of Quantitative Testing based on observed leakage will not be permitted.
         2) Defects identified for repair during Qualitative Testing shall be repaired to the satisfaction of the Engineer before approval of the structure.
      b. Report the results of quantitative testing.
         1) Submit completed Attachment A - Leakage Test Report or at a minimum, include the information specified in Attachment A - Leakage Test Report.
      c. Unlined concrete structures:
         1) Fill to the designated water surface elevation. Maintain that level for at least 72 hours before recording initial water levels for leakage test.

2) Duration of test:
   a) Theoretical time required to lower the water surface in the structure by 3/8 inch when leakage is occurring at the maximum allowable rate specified in subsequent paragraphs of this Section.
   b) Duration ("D") of the test in days is determined by the following equation:

$$D = \frac{0.375 \text{ inches}}{(0.0005 \text{ in/in/day} \times H \text{ ft} \times 12 \text{ in/ft})}$$

Where: H = maximum liquid depth

(1) Round results upward to the next full 24-hour period (day).
(2) Minimum duration of test: 24 hours (1 day).
(3) Maximum duration of test: 120 hours (5 days).

d. Lined concrete structures and secondary containment areas:
   1) Fill to the designated water surface elevation. Recording of water levels for leakage tests may begin as soon as the designated water surface level is reached and the water surface is calm.
   2) Duration of test: 72 hours (3 days).
e. Measurements: Water level:
   1) Record water levels at 24-hour intervals for the full duration of the test period.
   2) Measure water levels at not less than 2 locations on opposite ends of the structure and preferably at 4 locations spaced equally around the structure. Mark locations on the structure and take measurements at the same locations throughout the duration of the test.
   3) Measure, to an accuracy of 1/16 inch, the vertical distance to the water surface from a fixed point on the structure above.
f. Measurements: Temperatures:
   1) As part of the first and last sets of level measurements, record water temperature at a depth of 18 inches below the water surface. Measure temperature at the same locations where level measurements are taken.
   2) Record ambient temperature at the time of each water level measurement.
g. Measurements: Evaporation and precipitation:
   1) Measure evaporation and precipitation by floating pans inside the structures during testing.
      a) For uncovered structures, measure both evaporation and precipitation.
      b) For covered structures that are well ventilated, measure evaporation.
   2) Measure using specially constructed clear containers:
      a) Provide clear plastic, calibrated, open-top containers not less than 18 inches in diameter and 18-inches deep.
      b) Partially fill containers with water and float inside the structure. Make provisions to hold containers in place at each

measurement location, but away from structure walls and items passing overhead, such as beams or pipes.

c) Measure initial depth of water in each device. Measure changes in water level in each device at the same time measurements of the water level inside the structure are taken.

h. Restart of test:
   1) Engineer may order a restart of the test when, in the Engineer's opinion, measurements have become unreliable due to unusual precipitation or other factors.
   2) If measurements or observed leakage during the testing period indicate that the allowable leakage requirements will be exceeded, the test may be terminated before completion of the full test period. Take appropriate actions to correct problems before restarting the test.

i. Calculations of leakage test results:
   1) For each section of the structure tested, use water surface level records to calculate average loss of volume per 24-hour interval.
      a) For each 24-hour interval during the test, calculate the average of all measured drops in water level around the structure.
      b) Use the average drop thus determined to calculate an average loss of volume for each 24-hour interval.
   2) Adjustments to leakage calculations:
      a) For uncovered basins, calculations shall be corrected for precipitation added to the structure.
      b) Calculations may be corrected for evaporation and water temperature.

j. Evaluation criteria:
   1) Unless otherwise specified, the average loss of volume during any 24-hour interval shall not exceed the limits shown in Table A.

Table A - Loss of Volume Criteria for Leakage Tests

Structure Type	Maximum Loss of Water Volume
Structure fully lined prior to leakage test.	No measurable loss over 72-hour test period.
Secondary containment areas.	
Structure with monolithically placed membrane floor slab.	0.0125 percent of volume per 24-hour period.
Concrete paved canals, drying beds, lagoons, and similar structures.	0.100 percent of volume per 24-hour period.
Other containment structures.	0.050 percent of volume per 24-hour period.

k. Repairs and retesting:
   1) Structures and portions of structures that have satisfied the qualitative requirements of HST-100 but have failed to satisfy the quantitative requirements of HST-100 may be immediately retested for volume loss.
      a) If the structure fails the second test for volume loss, the structure shall be drained and the Contractor shall observe the interior for probable areas of leakage.
      b) Structure shall not be retested until repairs to the probable areas of leakage are complete.

3.05 REPAIRS FOR RETESTING

A. Locations showing damp spots or flowing water:
   1. Mark locations of visible leaks and damp spots.
   2. Drain structures for repair.
   3. Repair defects causing damp spots and flowing water using methods specified in Section 03300 - Cast-in-Place Concrete and approved by the Engineer.
      a. Repair both interior and exterior surfaces and make structures watertight.
      b. Submit proposed repair products and procedures for Engineer's review.
      c. Refill structures for retesting.
   4. Repeat filling, observations, and repairs until no leaks or damp spots appear.

B. Structures for which water volume loss exceeds the limits specified after adjustments for evaporation, and precipitation:
   1. Determine cause of volume loss.
   2. Drain structures of water.
   3. Repair defects causing loss of water volume using methods specified in Section 03300 - Cast-in-Place Concrete and approved by the Engineer.
      a. Submit proposed repair products and procedures for Engineer's review.
   4. Refill water-holding structures.
   5. Repeat testing and repairs until volume loss does not exceed specified limits.

END OF SECTION

ATTACHMENT A - LEAKAGE TEST REPORT

LEAKAGE TEST REPORT

PROJECT:		SUBMITTED BY:	
STRUCTURE:		WITNESSED BY:	
AREA:		TEST DATES:	
TEST DURATION:		TEST DURATION:	

Surface area of structure tested:		(square feet)
Volume of structure tested:		(cubic feet)
Volume of structure tested:		(gallons)
Measured loss through gates, etc.:		(gallons / day)
Allowable loss of water volume:		(per day)
Allowable loss of water volume:		(% in 24 hours)
Allowable measured loss over test duration (inches):		
Measured loss of water:		(gallons / day - From E below)
Measured loss of water volume (%):		(in 24 hours - From E below)

Water Temperature: Start of test: °F End of test: °F

			Water Surface Elevation (top of structure to top of water)				
			Location #1	Location #2	Location #3	Location #4	Initials**
Day	Date	Time	(inches)	(inches)	(inches)	(inches)	
1							
2							
3							
4							
5							
Changes in Level:							

A. Average change in level (feet): _____ (Average of total charges for all locations)

B. Correction for precipitation: _____ (Measured from pan)

C. Correction for evaporation: _____ (Measured from pan)

D. Corrected change in level (CL): _____

E. Total days tested: _____

F. Average measured % water loss in 24 hours: _____ = $\frac{\text{(CL) x (surface area) x 100}}{\text{(initial water volume) x (number of test days)}}$

Notes and field observations**

**Place date and initials at the beginning of each entry.

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Contract closeout requirements.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Final Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

J. Polish waxed woodwork and finish hardware.

K. Wash tile.

L. Wax and buff hard floors, as applicable.

M. Wash and polish glass, inside and outside.

N. Wash and shine mirrors.

O. Polish glossy surfaces to clear shine.

P. Vacuum carpeted and soft surfaces.

Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.

R. Clean ducts, blowers, and coils when units were operated without filters during construction.

S. Clean light fixtures and replace burned-out or dim lamps.

T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from Owner of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to Final Completion of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Substantial Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF PLANT FACILITIES

A. Clean channels, pipe, basins, reservoirs, and tanks before running of 7-day test, or before facility goes online when 7-day test is not required.

B. Wash, wherever practicable, or broom sweep channels, pipe, basins, reservoirs, and tanks.

C. Disinfect filter basins, reservoirs, clear wells, tanks, channels, and piping intended to carry potable water as follows or in accordance with AWWA Standards.

D. Provide ample sampling outlets in pipe for testing.

E. Fill pipe and other plant facilities with chlorine solution of sufficient strength to retain residual of not less than 10 parts per million at end of 24 hours.

F. When reservoirs and basins are too large to be economically disinfected by filling with chlorine solution, spray reservoirs and basins with solution containing 100 parts per million of chlorine.

G. After disinfection, rinse entire potable water system with potable water sufficient to reduce chlorine residual to not more than 0.6 parts per million throughout system before system is put into service.

1.07 FINAL CLEANING AND DISINFECTION OF SYSTEMS OF POTABLE WATER MAINS

A. Clean interior of pipe and fittings.

B. When pipe contains dirt that cannot be removed by flushing, swab pipe interiors with solution containing not less than 500 parts per million of chlorine until clean.

C. Flush 12-inch in diameter and smaller pipe as thoroughly as available water sources will permit.

D. Fill pipe with chlorine solution of sufficient strength to provide 10 parts per million chlorine residual at end of 24 hours.

E. Flush pipes with potable water until chlorine residual is less than 0.6 parts per million before pipe are put into service.

1.08 CLOSEOUT DOCUMENTS

A. See the General Conditions for additional requirements. Additional forms are included in Contract Documents with the General Conditions, including Certificate of Substantial Completion and Certificate of Final Completion.

B. Submit the following Closeout Submittals before Substantial Completion:
   1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.
   6. Keys and Keying Schedule.
   7. Completed contract requirements for commissioning and process start-up.

C. Submit the following Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punch list of items have been completed and Engineer and Owner are satisfied that all deficiencies are corrected.
   2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
   3. Release of claims as outlined in Conditions of the Contract.
   4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
   5. Final statement of accounting.

6. Submit Final (As-Built) Schedule as specified in Section 01321 - Schedules and Reports.

1.09 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

A. Submit the following:
   1. Certificate of Occupancy.
   2. Required Certificates of Inspection

1.10 PROJECT RECORD DOCUMENTS

A. Maintain at Project site, available to Owner and Engineer, 1 copy of the Contract Documents, shop drawings, and other submittals in good order:
   1. Mark and record field changes and detailed information contained in submittals and change orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
   4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
   5. Provide schedules, lists, layout drawings, and wiring diagrams.
   6. Make annotations in electronic format. conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Graphite

B. Maintain documents separate from those used for construction:
   1. Label documents "RECORD DOCUMENTS."

C. Keep documents current:
   1. Record required information at the time the material and equipment is installed and before permanently concealing.
   2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for Engineer's recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01321 - Schedules and Reports.

1.11 MAINTENANCE SERVICE

A. Maintenance service as specified in technical specifications.

1.12 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.13 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
   1. Work has been completed in accordance with the Contract Documents:
   2. Punch list items have been completed or corrected.
   3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies and send a second written certification to the Engineer that the Work is complete.
   3. Engineer shall re-inspect the Work.

1.14 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount.
   1. The original Contract amount.
   2. Additions and deductions resulting from:
      a. Change Orders.
      b. Units installed and unit prices.
      c. Set-offs for uncorrected or incomplete Work.
      d. Set-offs for liquidated damages.
      e. Set-offs for reinspection payments.
      f. Extended engineering and/or inspection services and inspection overtime.
      g. Excessive shop drawings review cost by the Engineer.
      h. Other adjustments.
   3. Total Contract amount, as adjusted.
   4. Previous payments.
   5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.15 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS

2.01 SPARE PARTS

A. Owner may request advanced delivery of spare parts, maintenance products, and special tools.
   1. Deduct the delivered items from the inventory list and provide transmittal documentation.

B. Prior to Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to Owner at a location on site chosen by the Owner.
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01782

OPERATION AND MAINTENANCE MANUALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Preparation and submittal of manual with requirements to operate and maintain the equipment.

1.02 PREPARATION

A. General requirements:
   1. Provide dimensions in English units.
   2. Assemble material, where possible, in the same order within each volume.
   3. Reduce drawings and diagrams to 8-1/2- by 11-inch size, if possible unless otherwise specified.
   4. Complete forms on computer, handwriting not acceptable.
   5. Delete items or options not provided in the supplied equipment or system.
   6. Provide package control system annotated ladder logic for PLC, if applicable.

B. Electronic requirements:
   1. File format:
      a. Entire manual in PDF format.
         1) Include text and drawing information.
         2) Provide a single PDF file even if the hard copy version is broken into separate binders due to being large.
         3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.).
            a) If material is not available in native format and only available in paper format, remove smudges, fingerprints, and other extraneous marks before scanning to PDF format.
            b) Hard copy record drawing requirements:
               (1) Provide a single multipage PDF file of each set of the scanned drawings.
               (2) Page 1 shall be the cover of the drawing set.
            c) At file opening, display the entire cover.
               (1) Scan drawings at 300 dots per inch (DPI) minimum, black and white, Group IV Compression, unless otherwise specified.
               (2) Scan drawings with photos in the background at 400 dots per inch (DPI), black and white, Group IV Compression.
         4) Pagination and appearance to match hard copy.
         5) Searchable.
         6) Scanned images are not acceptable.
         7) Bookmarks:
            a) Bookmarks shall match the table of contents.

b) Bookmark each section (tab) and heading.
c) Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
d) At file opening, display all levels of bookmarks as expanded.

8) Thumbnails optimized for fast web viewing.

b. Drawing requirements:
1) Provide additional copy of drawings in most current version of AutoCAD format.
2) Drawings shall have a white background.
3) Drawing shapes shall not degrade when closely zoomed.
4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
5) Delete items or options not provided in the supplied equipment or system.

2. Media:
a. USB flash drive.
b. Secure File Transfer Protocol (SFTP).

3. Label media with the following information:
a. Operation and Maintenance Manual.
b. Equipment name.
c. Specification Section Number
d. Equipment tag number.
e. Owner's name.
f. Project number and name.
g. Date.

4. If multiple submittals are made together, each submittal must have its own subdirectory that is named and numbered based on the submittal number.

1.03 CONTENTS

A. Table of Contents: General description of information provided within each tab section.

B. Complete Attachment A - Equipment Summary Form.

C. Description of system and components.

D. Description of equipment function, normal operating characteristics, and limiting conditions.

E. Online resources.

F. Telephone resources.

G. Approved submittals.
1. Markup with any field changes.
2. Final programming.

H. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

I. Operating procedures:
   1. Step-by-step instructions including but not limited to the following:
      a. Safety precautions and applicable Safety Data Sheets.
      b. Guidelines.
      c. Other information as needed for safe system operation and maintenance.

J. Preventative maintenance procedures:
   1. Recommended steps and schedules for maintaining equipment.
   2. Troubleshooting.

K. Lubrication information: Required lubricants and lubrication schedules.

L. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

M. Manufacturer's technical reference manuals.

N. Warranties, including date of applicability.

1.04 SUBMITTAL

A. Provide 2 hard copy sets and 1 PDF set, submitted electronically.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

ATTACHMENT A - EQUIPMENT SUMMARY FORM

EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT TAG NUMBER(S) _____

4. LOCATION OF EQUIPMENT _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

_____

_____

_____

6. NAMEPLATE DATA -
   - Horsepower _____
   - Amperage _____
   - Voltage _____
   - Service Factor (S.F.) _____
   - Speed _____
   - ENC Type _____
   - Capacity _____
   - Other _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

   Name _____

   Address _____

   Telephone Number _____

8. MAINTENANCE REQUIREMENTS:

Maintenance Operation	Frequency	Lubricant (if applicable)	Comments
(List each operation required. Refer to specific information in Manufacturer's Manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

9. LUBRICANT LIST:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 7 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

10. SPARE PARTS (recommendations)_____

_____

11. COMMENTS_____

12. GENERAL INFORMATION:

Date Accepted*: _____

Expected Life*: _____

Project Name & Number: _____

Design Engineer: _____

13. WARRANTY:

Start Date: _____

Expiration Date: _____

Prorated: _____

SECTION 01783

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Warranty and bonds requirements.

1.02 SUBMITTALS

A. For each item of material or equipment furnished under the Contract:
   1. Submit manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
   2. Submit manufacturer's special warranty when specified.

B. Provide consolidated warranties and bonds within 15 calendar days of Substantial Completion.
   1. Contents:
      a. Organize warranty and bond documents:
         1) Include Table of Contents organized by Specification Section number and the name of the product or work item.
      b. Include each required warranty and bond in proper form, with full information, certified by manufacturer as required, and properly executed by Contractor, or subcontractor, supplier, or manufacturer.
      c. Provide name, address, phone number, and point of contact of manufacturer, supplier, and installer, as applicable.
   2. Hardcopy format:
      a. Submit original of each bond.
   3. Electronic copy in PDF format:
      a. Submit through the web based document management system.
      b. Electronic copy of warranties shall also be included in the Operations and Maintenance Manual for each piece of equipment. See Section 01782 - Operations and Maintenance Manuals.

1.03 OWNER'S RIGHTS

A. Owner reserves the right to reject warranties.

B. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

1.04 RELATIONSHIP TO GENERAL WARRANTY AND CORRECTION PERIOD

A. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both Contractor's general warranty and the correction period requirements.

B. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor's general warranty, nor does such affect or limit Contractor's performance obligations under the correction period.

1.05 MANUFACTURER'S 1 YEAR WARRANTY MINIMUM REQUIREMENTS

A. Written warranty issued by item's manufacturer.

B. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Contractor.

C. Covers all costs associated with the correction of the defect, including, but not limited to, removal of defective parts, new parts, labor, and shipping.

D. Provides a timely response to correct the defect.
   1. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.
   2. In the case that Owner has to provide temporary equipment to replace function of warranted item requiring repair or replacement, manufacturer shall reimburse Owner for such costs associated with the temporary equipment.

E. Warranty commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.

F. Duration of warranty: 1 year.

1.06 MANUFACTURER'S SPECIAL WARRANTY

A. Manufacturer's special warranty is a written warranty published by the manufacturer which includes the requirements as specified in the Technical Section.
   1. Project-specific information and requirements.
   2. Properly executed by product manufacturer.
   3. Expressly states that its provisions are for the benefit of the Contractor or Owner.
   4. Manufacturer's special warranties commence on the date that the associated item is certified by Engineer as substantially complete.

1.07 WARRANTY WORK

A. Contractor's responsibilities:
   1. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the product, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

B. Replacement cost:
   1. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of the Contract Documents.
      a. Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.

C. Related damages and losses:
   1. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

D. Owner's recourse:
   1. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.

E. Reinstatement of warranty:
   1. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
      a. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.08 IMPLIED WARRANTIES

A. Warranty of title and intellectual 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 rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Implied warranties: Duration in accordance with Laws and Regulations.

1.09 BONDS

A. Equipment bond and other bond requirements as specified in the Technical Sections.

B. Bonds commence running on the date of substantial completion.
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of bond period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01850

DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design criteria for use in the selection of equipment and appurtenances specified in Technical Sections of these Specifications and indicated on the Drawings.
   2. Criteria for design of systems, components and equipment fabricated off site and shipped to the Work for installation.
   3. Criteria for design of anchors to connect equipment and appurtenances to supports and structures.

B. The criteria in this Section apply throughout the Work, unless additional criteria, or more restrictive criteria, are indicated.
   1. Additional criteria and requirements relevant to specific locations, specific materials, and specific equipment are indicated on the Drawings, and in the Technical Sections.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures. (ASCE 7).

B. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
   1. ASHRAE Fundamentals Handbook.

C. International Code Council (ICC):
   1. International Energy Conservation Code (IECC).
   2. International Plumbing Code (IPC).

D. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA):
   1. Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd edition 2008.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA - SITE INFORMATION

A. Site name: Jordan Valley Water Treatment Plant Filter & Chemical Feed Upgrades Harriman, Utah.
   1. Street address: As specified in Section 01110 - Summary of Work.
   2. Site elevation (approximate):
      a. 4,750 feet above mean sea level.

3. Groundwater elevation:
    a. See Project geotechnical reports, for information.
    b. For design of buried and partially buried construction:
        1) Groundwater is expected to be below the level of construction. Mapping shows groundwater is expected to be at depths greater than 30 feet.

2.02 DESIGN CRITERIA - REGULATORY REQUIREMENTS

A. Requirements of authorities having jurisdiction over the Project are included in Section 01410 - Regulatory Requirements.

2.03 DESIGN CRITERIA - OPERATING ENVIRONMENT

A. Drawings and Technical Sections include additional criteria and requirements relevant to specific locations, materials, and equipment.

B. Outdoor conditions:
    1. 2021 IECC: Climate Zone 5B – Cool Dry.
    2. 2021 ASHRAE site climatic data location: Salt Lake City International Airport, WMO 725720.
    3. Temperature criteria: As specified in the following Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook.

Table: Design Temperatures - Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook

Condition	Cool dry.
Hottest Month DB Range:	25 degrees Fahrenheit.
Winter:	At or above this temperature 99.6 percent of the time: 9 degrees Fahrenheit dry bulb.
Summer:	At or above this temperature 0.4 percent of the time: 99 degrees Fahrenheit dry bulb.

    4. Rainfall intensity:
        a. Reference: 2021 International Plumbing Code (IPC):
            1) 1.5 inches per hour (100-year, 1-hour rainfall).

C. Indoor conditions:
    1. HVAC:
        a. As specified in Section 15936 - Instrumentation and Control Devices for HVAC.

2.04 DESIGN CRITERIA - STRUCTURAL

A. General:
    1. Criteria for structural design of:
        a. Equipment at locations subject to seismic events.
        b. Equipment exposed to outdoor environments.
        c. Equipment supports and bracing, and anchorage of such items to building and non-building structures.

d. Structures provided for the Work through Delegated Design.
e. Manufactured and prefabricated structures, and anchorage of such structures to foundations or other supporting elements.

2. Structural design criteria used by the Engineer of record and required by the building code to be indicated on the Drawings are included on the Contract Drawing titled “General Structural Notes.”

B. Delegated Design:
1. As specified in Section 01357 - Delegated Design Procedures.
2. Structural engineering design shall be performed by a Civil or Structural Engineer licensed in the State of Utah with adequate experience in the field related to the delegated design**.**

C. Structure risk category:
1. Develop design loads and provide detailing in accordance with the provisions of ASCE 7 and the building code specified in Section 01410 - Regulatory Requirements, based on the Structure Risk Category indicated in Table: Project Structures - Risk Category and Seismic Design Information.

D. Seismic loads:
1. Seismic design parameters: Basic parameters - ASCE 7:
a. Ground motion MCE_R, 5 percent damped:
1) Short periods, Ss = 1.171 g.
2) 1 second period, S_1 = 0.424 g.
b. Peak ground acceleration, MCE_G:
1) Peak ground acceleration, PGA = 0.519 g.
c. Mapped long-period transition period:
1) TL = 8 seconds.
2. Structures - General:
a. Seismic Design Category (SDC): As indicated in the Drawings and in the following Table: Project Structures - Risk Category and Seismic Design Information.

Table: Project Structures - Risk Category and Seismic Design Information

Description: Water Treatment Facility

Area	Description	Risk Category	Site Class	S_{DS}	S_{D1}	Seismic Design Category(1)
41	Backwash Supply Tank	IV	C	0.937	0.424	D
63	Chlorine Building	IV	C	0.937	0.424	D
65	Caustic Soda Building	IV	C	0.937	0.424	D

Notes:

(1) Seismic Design Category for Delegated Design, and for seismic certification of electrical and mechanical equipment as required by ASCE 7.

b. Structure response modification coefficient, R:
1) In accordance with ASCE 7 and the requirements of the Technical Sections.

3. Structures - Tanks and vessels.
    a. Includes: Tank structures, tank supports, and anchorage to structures or foundations.
    b. Liquid storage structures (e.g., basins and tanks).
        1) Include impulsive and convective (“sloshing”) effects.
        2) Component response modification factor - impulsive effects, Ri: as indicated on the Drawings. In accordance with ASCE 7, Table 15.4-2.
        3) Component response modification factor - convective effects, Rc = as indicated on the Drawings.
    c. Dry material storage structures (e.g., silos, hoppers):
        1) Include effects of stored materials.
        2) Component response modification factor - impulsive effects, Ri: as indicated on the Drawings. In accordance with ASCE 7, Table 15.4-2.
4. Non-structural components - General:
    a. Includes:
        1) Mechanical and electrical equipment; anchorage of equipment to structures or supports; design of supports; and anchorage of supports to structures or foundations.
        2) Distribution systems associated with mechanical and electrical equipment such as piping, ductwork, conduits, cable trays, raceways, bus ducts, and similar items; anchorage of such systems to supports and structures; and bracing or such systems.
    b. Seismic design requirements for non-structural components are based on the Seismic Design Category (SDC) of the structure or facility where the equipment is installed.
    c. Design components, component anchorage, and component connections to piping and utilities in accordance with the requirements of ASCE 7, Table 13.2-1.
    d. Component amplification factor (ap), response factor (Rp), and overstrength factor for anchorage to concrete (Ωo):
        1) Mechanical and electrical components and systems: In accordance with ASCE 7, Table 13.6-1, unless otherwise indicated in the Technical Sections for these items.
        2) Architectural components and systems: In accordance with ASCE 7, Table 13.6-1, unless otherwise indicated in the Technical Sections for these items.
    e. Component importance factor, I_p:
        1) In accordance with the following Table: Component Importance Factor for Seismic Design, I_p.
        2) For items not listed in Table: Component Importance Factor for Seismic Design, I_p, designate importance factor in accordance with the provisions of ASCE 7, Chapter 13, and submit to the Engineer for review prior to developing calculations and details related to that component.

Table: Component Importance Factor for Seismic Design, I_p		
Structure Seismic Design Category	**Components**	**I_p**
All	Electrical: Items and distribution system components specified in Division 16 - Electrical.	1.5
All	Process Control and Instrumentation Systems: Components and distribution systems specified in Division 17 - Instrumentation and Controls.	1.5
All	Fire protection: Components and distribution systems specified in Section 10520 - Fire Protection Specialties.	1.5
All	Conveyance and distribution systems and supports for toxic, highly toxic, hazardous, or explosive substances as specified in Divisions 6 through 15.	1.5
All	Conveying equipment: Items specified in Division 14	1.5
All	Equipment and components specified in Divisions 11 through 15, except HVAC and plumbing components listed below.	1.5
All	Plumbing equipment specified in the following Sections: 15400 - Plumbing Systems 15430 - Emergency Eye/Face Wash and Shower Equipment	1.0
All	HVAC equipment specified in the following Sections: 15735 - Positive Pressurization Equipment 15740 - Heat Pumps 15745 - Makeup Air Unit 15762 - Heating Units 15830 - Fans	1.0
All	Other equipment not listed above.	1.0
Notes: (1) Not used.		

5. Non-structural components: HVAC ductwork.
    a. Component importance factor, I_p: Determine in accordance with ASCE 7, Section 15.4.1.1.
    b. Seismic design category:
        1) See Table: Component Importance Factor for Seismic Design, I_p (preceding).
    c. SMACNA seismic hazard level.
        1) Seismic hazard level for design of heating, ventilating, and air conditioning ductwork in accordance with SMACNA Seismic Restraint Manual:
            a) SMACNA Seismic hazard level = D.

E. Wind loads:
   1. Design structures and non-structural components that are exposed to wind to withstand design wind loads.
      a. Reduction of wind loads based on shielding effects of surrounding structures or components is not allowed.
      b. Design for wind loading is not required for non-structural components and for non-building structures located inside enclosed buildings.
   2. Design parameters, unless otherwise indicated on the Drawings:
      a. Basic wind speed:
         1) 115 miles per hour (33 feet height, 3-second gust).
      b. Exposure category: C.
      c. Topographic factor, Kzt: 1.0.
      d. Wind pressure for design of “components and cladding”.
         1) “Components and cladding” includes doors, windows, siding panels, skylights, parapets and similar architectural elements.
         2) Minimum wind pressure for components and cladding, strength level:
            a) Wall elements: Calculate element by element in accordance with ASCE 7, Chapter 30.
            b) Roof elements: Calculate element by element in accordance with ASCE 7, Chapter 30.

F. Snow loads:
   1. Design for snow loading is not required for non-structural components and for non-building structures located inside enclosed buildings.
   2. Design parameters:
      a. Ground snow load: pg = 38 pounds per square foot.
      b. Flat roof snow load: pf = 35 pounds per square foot, minimum.
      c. Exposure factor, minimum: Ce = 1.0, partially exposed.
      d. Thermal factor, minimum: Ct = 1.1, kept just above freezing or cold ventilated roof where thermal resistance exceeds R-value > 25 ft^2•°F•hr/Btu.
      e. Importance factor, minimum: Is = 1.2.
      f. Drifting:
         1) Consider effects of adjacent and nearby structures and equipment on drift loads in accordance with ASCE 7, Chapter 7.

G. Atmospheric icing design criteria in accordance with ASCE 7, Chapter 10:
   1. Nominal ice thickness due to rain (33-foot height, 3-second gust): 0.25 inches.

H. Rainfall loads:
   1. Determine rainfall loads using rainfall intensity specified in this Section, and including effects of exposed surface slope, height above surface to discharge elevation, and deflection of ponded surfaces.

I. Operational loads:
   1. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), surge or “water hammer,” and other load conditions.
   2. Design for loads indicated by the equipment manufacturer.
   3. Design for loads indicated in the Technical Sections for equipment and appurtenances.

J. Serviceability considerations:
    1. Deflection, unless otherwise indicated on the Drawings, or specified:
        a. Beam deflection as fraction of span:
            1) Walkways and platforms: Total load = L/240; live load = L/360.
            2) Equipment supports: L/450.

PART 3 EXECUTION

3.01 GENERAL

A. Design approach and criteria in accordance with:
    1. Regulatory requirements, including but not limited to the building code specified in Section 01410 - Regulatory Requirements.
    2. Reference standards and project-specific design criteria listed in this Section.
    3. Specific requirements for individual elements and components of the Work as specified in subsequent Technical Sections.

B. In the event of conflicts between design criteria, contact Engineer for interpretation.

C. Where Owner-Delegated Design is required by the Specifications, prepare and submit designs as specified in Section 01357 - Delegated Design Procedures.

3.02 DELEGATED DESIGN

A. Where Delegated Design is required by the Technical Sections, prepare and submit designs as specified in Section 01357 - Delegated Design Procedures.

B. Calculations:
    1. Where submittal of calculations is required:
        a. Provide complete calculations, including sketches to illustrate the design concepts being evaluated, and details to fully describe proposed construction.
    2. Requirements for seismic design calculations will be waived for the following:
        a. Furniture and storage racks 5 feet in height or less.
        b. Moveable equipment that does not need to be anchored to the ground during operation.
        c. Mechanical and electrical equipment and components located in structures designated as Seismic Design Category A or B.
        d. Mechanical and electrical equipment and components located in structures designated as Seismic Design Category C and where the component importance factor, I_p, is equal to 1.0.
    3. Requirements for wind design calculations will be waived for the following:
        a. Equipment and components located inside structures, and away from the effects of wind loads.

C. Shop Drawings:
    1. Describing components and manufacturer’s requirements for connections.
        a. Include details for connections of components to structures and supports.
        b. Include details for anchoring bracing to structures where required.

3.03 DESIGN - ANCHORS FOR EQUIPMENT, COMPONENTS, AND BRACING

A. General:
   1. Engineer's approval of anchor designs is required before placement of construction that supports or provides bracing for anchored equipment and components.
      a. Prepare anchor designs after Engineer's approval of the products and layout, and before placement of concrete or masonry that supports them.
   2. Adjust equipment pad sizes and add additional anchor confinement reinforcing to provide required strength at anchorage points between equipment and pad, and between pad and structure.
   3. Supports and bracing:
      a. Design and install braces and anchors to transfer forces from equipment and components to the lateral force resisting system of the surrounding structure.
      b. Anchor and brace piping, ductwork, and electrical distribution components so that lateral or vertical displacement does not result in damage to or failure of essential architectural, mechanical, or electrical equipment.
         1) Provide supplementary framing where required to transfer forces.
         2) Detail and locate braces and anchors to minimize differential movements between components and structure.

B. Preparation:
   1. Obtain manufacturer's information:
      a. Weight and dimensions of components.
      b. Layout and location of anchors that connect to equipment base plates, sole plates, skids, or pads.
      c. Sizes of holes for anchors that will be provided in equipment bases or support frames.

C. Analysis and design:
   1. Perform and submit calculations to determine anchor designs at locations where equipment and equipment supports are connected to the supporting structure.
      a. Indicate number, size, type, and material for anchors.
   2. In determining forces at locations where equipment is anchored to structures, include effects of:
      a. Equipment self-weight and operating weight.
      b. Location of equipment center of mass.
      c. Forces from equipment operation including, but not limited to:
         1) Effects of internal contents including weight and sloshing.
         2) Effects of thrust, surge, and water hammer where specified.
         3) Equipment reactions and operating torque.
         4) Equipment vibration.
         5) Thermal effects from equipment and from distribution systems connected to the equipment (piping, ducts, and electrical).
         6) Other load or displacement inducing conditions.
      d. Forces on equipment from loads specified in this Section.
         1) Include effects of wind, snow, and icing loads where applicable.
         2) Design for load combinations indicated in ASCE 7, unless otherwise specified or indicated on the Drawings.

3) Seismic and wind loads: For equipment and tanks with weight that varies based on the volume of contained material, determine anchor forces to accommodate the full range of filled, partially filled, and empty conditions.

3. Determine forces and overturning moments at equipment supports and at locations where supports are anchored to structures.
   a. Indicate shear force and associated axial force at each anchor.
4. Do not use friction to resist sliding resulting from seismic or wind forces.
   a. Resist sliding only by direct application of sliding loads to fasteners as bearing, shear, tension, or compression forces.
5. Using combined shears and axial forces at each anchor, design anchors and anchor groups for ductile failure.
   a. Ductile failure: Anchor yield before failure of base material, typically concrete or masonry, at the anchor.
6. Anchor selection:
   a. Provide anchors type indicated on the Drawings.
   b. Where anchors are not specifically indicated on the Drawings, select in accordance with the following:
      1) Anchors that resist seismic and wind forces:
         a) Cast-in-place forged hex-head anchor bolt.
      2) Anchors loaded in sustained tension:
         a) Cast-in-place forged hex-head anchor bolt.
      3) Anchors for reciprocating, vibrating, and rotating equipment:
         a) Cast-in-place forged hex-head anchor bolt.
   c. Do not use post-installed anchors, mechanical or adhesive, unless:
      1) Post-installed anchors are indicated on the Drawings, or
      2) Post-installed are approved by the Engineer prior to placement of the surrounding concrete or masonry.
   d. Anchor diameter:
      1) Select diameter so that hole in base plate is not greater than 125 percent of the nominal diameter of the anchor, nor greater than the diameter of the anchor plus 1/4 inch.
7. Determine number, size, layout, and minimum effective embedment for anchors.
   a. Layout includes anchor spacing and required distance(s) from anchor to edge(s) of supporting concrete or masonry.
   b. Anchors in concrete: Design based on minimum specified 28-day compressive strength, f'c, as follows:
      1) Concrete placed for this Work: f'c = as indicated on the Drawings pounds per square inch.
      2) Existing concrete in place prior to this Work: f'c = as indicated on the Drawings pounds per square inch.
   c. Anchors in masonry: Design based on minimum specified compressive strength, f'm, as follows:
      1) Concrete masonry placed for this Work: f'm = as indicated on the Drawings pounds per square inch.
      2) Existing concrete masonry in place prior to this Work: f'm = as indicated on the Drawings pounds per square inch.

8. Prepare Drawings showing construction details of anchor designs.
9. Submit design calculations and Drawings prior to placement of anchors, and of the structural elements to which they will connect.

END OF SECTION

SECTION 02050

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Material requirements for soils and aggregates.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. T 11 - Standard Method of Test for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. T 27 - Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   3. T 90 - Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils.
   4. T 96 - Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

B. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D1883 - Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
   5. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   6. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   7. D4829 - Standard Test Method for Expansion Index of Soils.
   8. D 6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

A. American Public Works Association (APWA), Utah Chapter
   1. 2017 Manual of Standard Specifications (Standard Specifications)

1.03 MANUAL OF STANDARD SPECIFICATIONS SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: Reports for tests required by Sections of Standard Specifications.
   2. Certificates of Compliance: Certificates as required by Sections of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

B. Comply with Standard Specifications storage requirements, if applicable.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.

B. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

C. Comply with soil and aggregate material requirements in the Standard Specifications, unless specified otherwise.

2.02 NATIVE MATERIAL

A. Native soil:
   1. Sound, earthen material.
   2. Expansion index less than 35 when tested in accordance with ASTM D4829.
   3. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1-inch	100
Number 200	30 maximum

B. Native soil-select:
   1. Sound earthen material.
   2. Granular, well-graded material with a maximum particle size of 4 inches and a fines content between 5 and 15 percent when testing in accordance with ASTM D6913.
   3. Liquid limit less than 20 and plasticity index less than 10 when tested in accordance with ASTM D4318.
   4. Free from organic matter, clay cjunks, asphalt, construction debris and other deleterious material.
   5. Corrosion resistance requirements:
      a. Resistivity minimum (wet aggregates): 5,000 ohm-cm.

b. pH: 5.0 to 12.0.
c. Chlorides maximum: 100 parts per million.
d. Sulfates maximum: 200 parts per million.

2.03 AGGREGATE BASE COURSE

A. Material requirements:
1. Aggregate base as specified in the Standard Specifications.
2. Untreated base course.
3. Consists of hard durable particles of crushed rock, gravel, sand or other high quality mineral particle, or combination; screened or crushed to required size and grading; and free from organic matter, contamination from chemical or petroleum products, or other deleterious matter.
4. Materials derived from processing demolished or removed asphalt concrete are not acceptable.
5. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
a. Percentage of wear: Not to exceed 50 percent when tested in accordance with ASTM C131.
b. Plasticity index: Not to exceed 0 when tested in accordance with ASTM D4318.
c. Liquid limit: Not to exceed 20 when tested in accordance with ASTM D4318.
d. Sand Equivalent: Minimum 35 percent when tested in accordance with ASTM D2419.
e. California Bearing Ratio: Minimum 70 when tested in accordance with ASTM D1883.
f. Conforms to size and grade within the following limits when tested in accordance with ASTM C136.

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1 1/2 inch	100
3/4 inch	70 - 85
3/8 inch	55 - 75
No. 4	40 - 65
No. 16	25 - 40
No. 200	7 - 11

2.04 DRAIN ROCK

A. Material requirements:
1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.

4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 2

2.05 CAPILLARY BARRIER

A. Material requirements:
   1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
   2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
   3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
   4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
1 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 5

2.06 SAND

A. Clean, coarse, natural sand.

B. Non-plastic when tested in accordance with ASTM D4318.

C. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1/2 inch	100
Number 200	0 - 20

2.07 STABILIZATION MATERIAL

A. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.

B. Consists of clean, hard, durable particles of crushed rock or gravel; screened or crushed to the specified sizes and gradations; and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

C. Shall be free of slaking or decomposition under the action of alternate wetting and drying.

D. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having 3 or more fractured faces.
   1. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes the 3/8-inch sieve but is retained on the No. 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.

E. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
3/4 inch	90 - 100
No. 4	0 - 10
No. 200	0 - 2

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02085

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 SUMMARY

A. Design, fabricate, and install precast chemical pull boxes of the size and type indicated on the Drawings and specified.

B. Section includes:
   1. Precast chemical pull boxes and accessories.

C. Alternates:
   1. Contractor may propose to construct cast-in-place structures in lieu of the precast structures specified.
      a. Obtain Engineer's acceptance of this alternative before submitting, providing, or installing.
      b. Submit full information on design and detailing of proposed alternatives including design details and drawings of the same types required by this Section for precast structures.

1.02 REFERENCES

A. American Association of State Highway Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C858 - Standard Specification for Underground Precast Concrete Utility Structures.
   4. C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
   5. C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

D. National Precast Concrete Association (NPCA).

1.03 DEFINITIONS

A. Precast Concrete: A concrete fabrication designed by a qualified engineer and subsequently fabricated at a qualified fabrication site, which is usually located some distance from the site where the fabrication will be installed.

1.04 SUBMITTALS

A. Product data: Manufacturer's catalog data, details, and warranties for the following items.
   1. Materials of construction.
   2. Joint details and joint-sealing materials.
   3. Data for hatches or covers and rings.
   4. Pulling iron details.

B. Shop drawings:
   1. Shop drawings for each structure shall bear the seal and signature of a professional civil or structural engineer licensed in Utah.
   2. Dimensioned and "to-scale" plans, sections, and details for each structure including:
      a. Layout plan for that structure.
      b. Sizes, locations, and vertical positions of penetrations.
      c. Locations and details for access openings and pulling irons.
      d. Details of structural reinforcement showing bar size and spacing; true position of reinforcement in structural members with clear concrete cover at both inside and outside faces; location, bar size, and spacing of added reinforcement around openings; and other details relevant to design and fabrication of the structure.
      e. Details of joints between adjacent precast sections, including provisions for overlap and for placement of sealants.

C. Design data:
   1. Structural calculations:
      a. Submit complete structural calculations for each structure.
      b. Provide calculations bearing the seal and signature of a professional engineer licensed in the Utah.
      c. Manufacturer's statement of materials used for fabrication and construction, in accordance with ASTM C858, for record. Include the following:
         1) Concrete mix design: For each concrete mix design to be used for the structures, include data describing:
            a) Source and type of cement.
            b) Sources, grading, and specific gravities of aggregates.
            c) Aggregate reactivity data.
            d) Concrete mix proportions and design strength.
            e) Type, name, and dosage of admixtures included in the concrete mix.
         2) Reinforcing steel: Mill certificates.

D. Test reports:
   1. Fabricator's tests for compressive strength of concrete used in structures, made in accordance with recommendations of ASTM C858.

E. Certificates:
   1. Manufacturer's current plant certification under NPCA for the structures to be supplied.
      a. Certification shall be current and in-effect at the time structures are manufactured.
   2. Manufacturer's certification that chemical pull boxes are in accordance with the requirements of ASTM C858.

F. Manufacturer's instructions:
   1. Instructions for handling and setting structures in place.

G. Manufacturer's field reports:
   1. Manufacturer's inspection reports in accordance with ASTM C1037.

H. Closeout documents:
   1. Warranties:
      a. Manufacturer's standard warranty for:
         1) Pull boxes and accessories.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Designer:
      a. Professional Civil engineer or Structural engineer qualified in the design of concrete structures and holding a current license in Utah.
   2. Manufacturer:
      a. Holding current NPCA plant certification for the products produced.
      b. Demonstrating at least 5 years of experience in the design, production, and installation of products of the type required for this Work.
      c. Capable of providing structural designs prepared by a professional engineer licensed in the state where the structures will be installed.
      d. Providing inspection during fabrication and handling in accordance with the requirements of ASTM C1037.
   3. Installer:
      a. Capable of providing equipment of adequate capacity and mobility to handle and set units with proper bearing on the subgrade and without damage to the unit.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, handling, and unloading:
   1. Package and brace structures to avoid damage during shipping and handling.
   2. Furnish crane or forklift for unloading and setting of pull boxes.

B. Acceptance at site:
   1. Structures delivered to the site with cracks, damage, and damaged or missing accessories shall be removed from the site and replaced at no additional cost to the Owner.

C. Storage and protection:
   1. Store concrete pull boxes and their appurtenances in areas protected from damage due to weather and site operations.

1.07 PROJECT CONDITIONS

A. Operating environment: As specified in Section 01850 - Design Criteria

1.08 WARRANTY

A. Provide manufacturer's standard warranty for precast structures and accessories.

PART 2 PRODUCTS

2.01 CHEMICAL PULL BOXES

A. General:
   1. Provide precast concrete chemical pull boxes configured and designed as indicated on the Drawings and specified.
   2. In accordance with ASTM C858 unless otherwise noted.
      a. Concrete: Provide units using Type II cement.

B. Manufacturers: One of the following, or equal:
   1. Oldcastle Precast.
   2. Or approved equal

C. Components:
   1. Floor:
      a. Construct floors as a monolith.
   2. Roof, walls, and base:
      a. Designed and rated to support vehicle and pedestrian loads at the spans indicated.
   3. Access covers:
      a. Cast iron frame and cover:
         1) Manhole rings and covers:
            a) Gray cast iron in accordance with ASTM A48, Class 30B with ring and cover machined to fit with flat bearing surfaces.
            b) Cover with word "CHEMICAL" cast into the top exposed face.
            c) Watertight gasket and concealed watertight pickhole.
            d) Manhole riser access:
               (1) Heavy-duty bottom flange frame with solid cover for placement on grade adjustment rings above top slab.
               (2) Manufacturers: The following or equal.
                  (a) Neenah Foundry Co.

D. Accessories:
   1. Provide accessories as indicated on the Drawings and specified.
   2. Pulling irons:
      a. Provide non-corroding cable pulling irons located for use with each chemical duct bank location.

b. Pulling irons may not be located on the floor.
c. Where pulling irons are installed on the wall, any pockets surrounding the irons shall have bottom surfaces sloped to drain.
d. Secure pulling eyes to structure reinforcement.

3. Exterior dampproofing:
a. As specified in Section 07110 - Dampproofing.
b. Field applied to wall and roof surfaces exposed to soil.

E. Fabrication:
1. Embeds:
a. Install embedded items with provisions for drainage to remove dripping or standing water, and to minimize corrosion.
1) Pulling irons may not be placed on the floor or in pockets that will collect water.
b. Concrete cover:
1) Provide minimum 0.75-inch clear concrete cover between embeds and surrounding reinforcement.
2) Provide minimum 1.25-inch clear concrete cover between embed and exterior face of wall.

F. Tests and inspections:
1. Test and inspect structures in accordance with ASTM C858 and ASTM C1037.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. General requirements:
1. Provide structures of the sizes and shapes indicated on the Drawings, with layouts, dimensions, and details as indicated on the Drawings and as specified.
2. Conform to the requirements of:
a. Project regulatory requirements as specified in Section 01410 - Regulatory Requirements.

B. Design requirements: Loads on structures:
1. In accordance with ASTM C857, except as modified in this Section.
2. Loads at the ground surface:
a. Load from heavy, frequently repeated vehicle traffic:
1) Designation "A-16" in ASTM C857 Table 1 (AASHTO HS20-44).
3. Lateral earth pressure loads:
a. Determine in accordance with the following requirements. Include effects of groundwater and seismic accelerations on lateral earth pressures.
1) Equivalent lateral pressure:
a) 60 pounds per square foot per foot of depth (triangular distribution).
b) Surface surcharge load:
(1) Backfill-induced live load surcharge of 240 pounds per square foot (rectangular distribution).
(2) In accordance with ASTM C857 Vehicle Load Designation "A-16" for "Roadway" or "A-0.3" for "Sidewalk" where such surcharge exceeds backfill loads described in the preceding paragraph.

c) Seismic design:
(1) As specified in Section 01850 - Design Criteria.
(2) On opposite sides of the structure that are perpendicular to the direction of acceleration, include equivalent lateral pressure (inverted fluid pressure distribution), beginning with a pressure of 0 at the base of the structure, and increasing at a rate of 37.5 pounds per square foot per foot of rise toward the ground surface.
(3) Apply seismic effects as additive force on side where the soil mass is being accelerated toward the structure, and as subtractive force on the opposite side where the soil mass is being accelerated away from the structure.

b. Soil-bearing pressure at base:
1) Maximum 4,000 pounds per square foot total pressure on prepared subgrade.

c. Lifting and handling loads:
1) Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.

d. Load combinations:
1) Design structures to sustain the specified loads individually or in combination.

4. Design requirements: Structural analysis, design, and detailing:
a. General:
1) Analyze and design structures including the effects of 2-way action ("plate action") and of load transfer around current and future openings.
2) Where structures include panels designed for future removal ("knockout panels"), design structures for loads and stresses with any combination of any or all such panels in place or removed.
3) Design structures in accordance with the requirements of ACI 318 and this Section.
4) Provide reinforcement at areas subject to tensile stress when loaded with the specified loads and combinations thereof.
5) Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in concrete sections.
6) Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of members in accordance with the following:
a) 2 inches.
7) Reinforcement details:
a) Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
b) Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
c) Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
8) Joints:
a) Provide structures with watertight joints between sections and detailed to minimize water infiltration at duct bank and conduit penetrations.

b) Provide structures with non-skid, shiplap or tongue and groove joints between sections.

5. Design requirements: Materials:
   a. In accordance with ASTM C858 except as modified in this Section.
   b. Proportion concrete mixes to resist damage from freezing and thawing in a moist environment, and for exposure to deicing chemicals. Conform to ACI 318 requirements for minimum specified compressive strength and air entrainment.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install precast chemical pull boxes as indicated on the Drawings and specified.

B. Install additional chemical pull boxes required so installation procedures will conform to chemical tubing pulling requirements.
   1. Include proposed locations and details of such additional chemical pull boxes with the submittals under this Section.

3.02 PREPARATION

A. Design:
   1. Prepare detailed and scalable layouts for each pull box showing locations of penetrations, clearances, locations, and sizes of access openings and major accessories.

B. Protection:
   1. Where chemical pull boxes are installed adjacent to existing site structures or utilities, provide excavation support or other protection as required to maintain those facilities in service and to prevent damage to both existing and new facilities.

C. Site preparation:
   1. Excavate and prepare exposed subgrade as indicated on the Drawings and as specified.
   2. Install and compact 6 inches of aggregate base course compacted to 95 percent and specified.
   3. Level foundation materials so that structures will be set plumb, and chemical lines will be at proper grade and alignment.
      a. Install with uniform bearing on foundation materials.
      b. Wedging or blocking of base sections for leveling over the foundation materials will not be permitted.

3.03 INSTALLATION

A. General:
   1. Protect chemical pull boxes from displacement, flooding, or flotation.

B. Chemical pull boxes:
   1. Install pull boxes in accordance with ASTM C891 and the provisions of this Section.
      a. In the event of conflicts, the more restrictive provisions shall apply.
   2. Clean and prime joints between adjacent precast sections.
      a. Install sealing compound between sections and provide watertight joints.
   3. Set covers at elevations indicated on the Drawings.
      a. Securely attach frames to top of precast structures and grade adjustment rings.
   4. Penetrations:
      a. Coat any reinforcement cut or exposed with minimum 2 coats of high solids epoxy as specified in Section 09960 - High-Performance Coatings.
         1) Apply epoxy coating applied over and at least 1-inch past the perimeter of the reinforcement.
   5. Install penetrations in accordance with the penetration details indicated on the Drawings.
      a. Place joint fillers and sealants before coating exterior concrete surface with bituminous dampproofing.
   6. Fill holes that were provided for handling or other temporary purposes with non-shrink cement grout using procedures as specified in Section 03300 - Cast-in-Place Concrete unless otherwise detailed by the manufacturer.
   7. After structures are set and before backfilling, coat exterior below-grade surfaces (around the sidewalls, over the top slab, and around any vertical risers to grade) with 2 heavy coats of bituminous dampproofing as specified in Section 07110 - Dampproofing.
      a. Apply dampproofing in accordance with the coating manufacturer's instructions and at a rate of 40 to 60 square feet per gallon per coat.
      b. Mask over at least 1 inch back from joint caulks or sealants and prevent dampproofing from coming in contact with those materials.
   8. Backfill chemical pull boxes as specified in Section 02300 - Earthwork.

C. Site tolerances:
   1. Set chemical pull boxes plumb and true at locations indicated on the Drawings.
   2. Tolerances on placing:
      a. Horizontal location: Plus or minus 1 inch.
      b. Vertical elevation: Plus or minus 1/2 inch.
      c. Plumb: Plus or minus 1/8 inch over 10 feet.

3.04 REPAIR/RESTORATION

A. Repair cracks or blemishes in concrete by methods acceptable to the Engineer. Submit proposed repairs for acceptance before commencing work.

3.05 ADJUSTING

A. After final grading is complete, adjust access covers to grade.

3.06 CLEANING

A. Before installation of chemical lines in chemical pull boxes, remove concrete spoil, forms, debris, silt, dust, and other foreign material.

B. Pressure wash interior of structures if required to provide clean interior surfaces.
   1. Block drains and provide pumps to remove washwater from structures.
   2. Do not permit washwater to drain into subgrade soils.

END OF SECTION

SECTION 02200

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Clearing, grubbing, and stripping project site.

1.02 DEFINITIONS

A. Clearing: Consists of removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which interferes with construction operations or are designated for removal.

B. Grubbing: Consists of the removal and disposal of wood or root matter below the ground surface remaining after clearing and includes stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 6 inches below the ground surface.

C. Stripping: Includes the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped. The depth of stripping is estimated to be 6 inches, but the required depth of stripping will be determined by the Engineer.

1.03 QUALITY ASSURANCE

A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.04 PROJECT CONDITIONS

A. Environmental requirements:
   1. For suspected hazardous materials found: As specified in Section 01354 - Hazardous Material Procedures.

1.05 SEQUENCING AND SCHEDULING

A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. Clearing:
   1. Clear areas where construction is to be performed and other areas as indicated on the Drawings, or specified in this Section, of fences, lumber, walls, stumps, brush, roots, weeds, trees, shrubs, rubbish, and other objectionable material of any kind which, if left in place, would interfere with proper performance or completion of the work, would impair its subsequent use, or form obstructions.
   2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.
   3. Contractor's temporary construction facilities: Fill or remove pits, fill, and other earthwork required for erection of facilities, upon completion of the work, and level to meet existing contours of adjacent ground.

B. Grubbing:
   1. From excavated areas: Grub stumps, roots, and other obstructions 3 inches or over in diameter to depth of not less than 18 inches below finish grade.
   2. In embankment areas or other areas to be cleared outside construction area: Do not leave stumps, roots, and other obstructions higher than the following requirements:

Height of Embankment over Stump	Depth of Clearing and Grubbing
0 feet to 2 feet	Grub stumps or roots 3 inches or over in diameter to 18 inches below original grade. Cut others flush with ground.
2 feet to 3 feet	Grub stumps 1 foot and over in diameter to 18 inches below original grade. Cut others flush with ground.
Over 3 feet	Leave no stumps higher than stump top diameter, and in no case more than 18 inches.

   3. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.

C. Stripping:
   1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.
   2. Deposit stripped material in accordance with following requirements:
      a. At locations acceptable to Engineer.
      b. Use accepted material in top 6 inches of areas to be used for future planting.
   3. Replace topsoil where indicated on the Drawings.

END OF SECTION

SECTION 02260

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for designing, providing, maintaining, and removing excavation support and protection.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.

B. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
   1. Design Manual 7.2 - Foundations and Earth Structures.
   2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.

C. United States Steel Corporation (USS):
   1. Steel Sheet Piling Design Manual.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.
   2. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes cantilevered sheet piling, internally braced sheet piling, slurry walls, soldier piles and lagging, and other similar shoring systems. Sloping of the soil is not shoring.
   3. Support levels: Level of tiebacks, wales, rakers, bottom of excavation, and other types of support.

1.04 SUBMITTALS

A. Shop Drawings and calculations:
   1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
   2. Sketches showing the condition at various stages of installation and removal of shoring.
   3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.

4. When utilities penetrate shoring, show location of penetrations on elevation of sides of shoring.
5. Show details for ground support and sealing around utility penetrations.
6. Indicate method used for installing driven shoring.

B. Control points and schedule of measurements:
1. Submit location and details of control points and method and schedule of measurements.
2. Survey data.

C. Detailed sequence of installation and removal of shoring:
1. Consider effects of ground settlement in sequence of installation and removal of shoring.
2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.

D. Furnish Submittals for excavation support and protection as complete package and include items required in this Section:
1. Incomplete Submittals will not be reviewed and will be returned for resubmittal as complete package.

1.05 SEQUENCING

A. Do not begin construction of any shoring or excavation operations until:
1. Submittals for shoring and dewatering have been accepted.
2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
3. Materials necessary for installation are on site.

B. Furnish Submittals a minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Where general engineering design practice is specified, provide Drawings and calculations that are performed and signed by civil or structural engineer registered in State where Project is located:
1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
2. Submit list of references acceptable to the Engineer that substantiate appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:
1. General:
a. For trench excavations 5 feet or more in depth and for trenches less than 5 feet in depth when there is potential for cave-in.
1) Perform design pursuant to general engineering design practice.

b. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code as specified in Section 01410 - Regulatory Requirements, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
c. Minimum safety factor used for design shall not be less than 1.5.
d. The calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
e. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
f. The location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
g. Generally acceptable references for design of shoring and excavations are as follows:
    1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
    2) NAVFAC Design Manual 7.2.
    3) NAVFAC Design Manual 7.3.
    4) USS Steel Sheet Piling Design Manual.
h. Maximum total deflection of shoring at any point on shoring shall not be more than 3/4 inch.

2. Soldier piles and lagging:
    a. Provide lagging over full face of excavation. Joints between pieces of lagging shall be tight to prevent loss of soil.
    b. Provide full face lagging around penetrations through lagging.
    c. If the soldier piles are installed in predrilled holes and are not concrete encased, fill predrilled holes with controlled low strength material as specified in Section 02312 - Controlled Low Strength Material (CLSM) after soldiers piles are installed.
    d. Assumed effective width for passive soil resistance:
        1) Effective width of driven soldier piles shall not exceed 2 times width of pile.
        2) Effective width of CLSM encased soldier piles in drilled holes shall not exceed 2 times width of pile.
        3) Effective width of concrete encased soldier piles shall not exceed 2 times width of concrete encasement.
    e. Fill voids behind lagging with gravel or other material acceptable to the Engineer.
    f. Apply loads from tie back soil, rock, or deadman anchors concentrically to soldier piles or wales spanning between soldier piles:
        1) Wales shall be back-to-back double channels or other members acceptable to the Engineer.
        2) Do not eccentrically load structural section of soldier piles or wales.
    g. Design soldier piles for downward loads including vertical loads from tieback anchors.
3. Soil anchors, rock anchors, and deadman anchors:
    a. Design tieback anchors for a safety factor of not less than 2 times calculated load from shoring.

b. Proof load production anchors to 125 percent of calculated load from shoring.
c. Lock off production anchors at calculated load from shoring.
d. Length of soil anchors used to calculate resistance to load from shoring shall not include any length within potential active pressure soil failure zone behind face of shoring.
e. Design tie rods for tieback anchors for 130 percent of calculated load from shoring.
f. Design tie rods for tieback anchors for 150 percent of the calculated load from shoring when tie rod couplers are used and for other conditions where stress concentrations can develop.

4. Set inside face of shoring back from structure not less than greater of following:
   a. 5 feet from face of wall.
   b. 2 foot 6 inches from edge of foundation.
   c. Depth of excavation below bottom of foundation.

C. Performance requirements:
1. General:
   a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
   b. Specified provisions:
      1) Complement, but do not substitute or diminish, obligations of Contractor for furnishing of safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of Work, structures, and other improvements.
      2) Represent minimum requirement for:
         a) Number and types of means needed to maintain soil stability.
         b) Strength of such required means.
         c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
3. Provide support for trench excavations for protection of workers from hazard of caving ground.
4. Provide shoring:
   a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
      1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
      2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.
   b. For trenches 5 feet and deeper.
   c. For trenches less than 5 feet in depth, when there is potential for cave-in.
   d. Where indicated on the Drawings.

5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
    a. Using stiff shoring systems.
    b. Following appropriate construction sequence.
    c. Using shoring system that is tight enough to prevent soil loss through the shoring.
    d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
    e. Design for safety factor of not less than 1.50.
    f. Providing surface runoff routing and discharge away from excavations.
    g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
    h. Where sheet piling is used, use interlocking type sheets:
        1) Sheet piles shall be continuous and driven in interlock.
        2) If bottom of the excavation is located below the water table, use “ball and socket” or “thumb and finger” type interlock.
    i. Not applying shoring loads to existing structures and other improvements.
    j. Not changing existing soil loading on existing structures and other improvements.
    k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Installation of shoring:
    1. Install means for providing safe and stable excavations as indicated in Submittals.

B. Removal of shoring:
    1. Except for concrete encased soldier piles, slurry walls, and similar shoring systems, remove shoring by completion of Work.
    2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
    3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
        a. Inject grout starting at bottom of void and progressively fill void to grade.
        b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
    4. Pressure preservative treated wood lagging may be left in place if acceptable to the Engineer.

C. Control points:
   1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
      a. Set control points on shoring support system:
         1) Set points at distances not exceeding 25 feet at each support level.
   2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
   3. Perform horizontal and vertical survey and measurement of control points at least once every week.
      a. Field notes shall show current measurement and change in measurement from first measurement taken.
   4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
   5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.

D. Maintenance:
   1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to the Engineer.
   2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to site grading for buildings, basins, reservoirs, boxes, roads, and other facilities.
   2. Backfilling and compacting under and around structures.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).
   2. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

A. Backfill Adjacent to Structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.

B. Embankments: Dikes, levees, berms, and similar facilities.

C. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SUBMITTALS

A. Copy of Property Owner's Agreement allowing placement of surplus soil material on their property.

B. Excavation plan:
   1. Describe/show planned conformance with excavation limits, dimensions, depths, and other constraints put forth in the Contract documents and/or Geotechnical report(s).
   2. Describe/show proposed shoring and excavation methods.
   3. Describe/show how excavation process will be sequenced and coordinated.

4. If confined site, describe/show how access will be maintained to necessary areas during excavation process.
5. Describe/show proposed equipment and location of equipment placement, if critical to excavation stability.

C. Testing lab: Submit Contractor's proposed testing laboratory capabilities and equipment.

D. Test reports:
1. Submit certified test reports of tests specified to be performed by the Contractor.
2. Sign and seal test reports by a registered Civil Engineer who practices geotechnical engineering registered in Utah).

1.05 QUALITY ASSURANCE

A. Initial compaction demonstration:
1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
a. 50 cubic yards of backfill adjacent to structures.
b. 100 cubic yards of embankment work.
c. 100 cubic yards of fill.
d. 50 cubic yards of roadway base material.
e. 50 cubic yards of road fill.
2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

B. Contractor shall perform work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP).

1.06 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
   2. Obtain acceptable import material from other sources if surplus obtained within Project site does not conform to specified requirements or are not sufficient in quantity.
   3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

2.02 MATERIALS

A. Water for compacting: Use water from source acceptable to Engineer.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course, Class 2 permeable, controlled low-strength material, drain rock, gravel, native material, sand, select material, and stabilization material where specified or indicated on the Drawings.
      b. If suitable surplus materials are available, obtain native material and select material from cut sections or excavations or imported materials.
   2. Aggregate base course materials: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   3. Capillary Barrier: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   4. Drain rock: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   5. Gravel: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   6. Native material: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   7. Sand: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   8. Select material: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   9. Stabilization material: As specified in Section 02050 - Soils and Aggregates for Earthwork.

C. Controlled low-strength material: As specified in Section 02312 - Controlled Low Strength Materials (CLSM).

D. Geotextile fabrics:
   1. Filter fabric: As specified in Section 02620 - Filter Fabric.
   2. Stabilization fabric: As specified in Section 02621 - Stabilization Fabric.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Character and quantity of material:
      a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
      b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in work to be performed.
      c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from onsite excavations or imported materials. Include in cost of work to be performed.
      d. Include wasting of excess material, if required, in cost of work to be performed.

3.02 PREPARATION

A. Backfills:
   1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified before placing backfill material or concrete.
   3. Do not place backfill against walls until:
      a. Walls have been cast full height of structure and concrete has reached the specified strength.
      b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
   4. Prior to backfilling:
      a. Remove forms.
      b. Clean trash and debris from the excavation site.
   5. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.

B. Embankments:
   1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified for embankments before placing of embankment material.
   3. If embankment areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

C. Fills:
   1. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts, hummocks,

and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for compacted fills before placing of fill material or concrete.
3. If fill areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

D. Roadway fills:
1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.
3. If roadway fill areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

E. Sloped surfaces for fill or foundations:
1. Foundations for fill having slopes in excess of 1 vertical to 4 horizontal:
   a. Bench or terrace to adequately key existing ground and fill built thereon.
2. Slopes of original hillsides and old fills: Bench minimum of 10 feet horizontally as fill is placed.
3. Provision of new benches:
   a. Start new bench wherever vertical cut of next lower bench intersects existing grade.
   b. Recompact material thus cut out along with new embankment material at no additional cost to the Owner.

3.03 INSTALLATION

A. General:
1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.
2. Dispose of surplus material on private property only when written permission agreement is furnished by owner of property. Submit copies of such agreements.
3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from project site at no additional cost to the Owner.
4. Stabilization of subgrade: Provide materials used, or perform work required, to stabilize subgrade so it can withstand loads that may be placed upon it by Contractor's equipment.

A. Borrow area:
1. The Owner has indicated that borrow is available from the west ditch or other areas on the west side of the Property Site. Suitability of the borrow material shall be determined by the Contractor and is subject to acceptance by the Engineer.

2. An off-project site for borrow has not been identified. Import material from source located off Project site selected by the Contractor is subject to acceptance by the Engineer.
3. There will be no additional cost to the Owner for use of imported material.

B. Compaction:
1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
2. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D1556, or with ASTM D6938.
4. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557.
5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill. The depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
6. Compact to percentage of maximum density as follows:
    a. Backfill adjacent to structures: 95 percent.
    b. Backfilling adjacent to foundation walls: 90 percent.
    c. Backfilling voids: 95 percent.
    d. Embankments: 95 percent.
    e. Demolition areas: As indicated on the Drawings.
    f. Other areas: 90 percent.
    g. Under present and future structures: 95 percent.
    h. Under roadways, parking and storage areas, curbs, and sidewalks: 95 percent.
    i. Upper 6 inches of cuts: 95 percent.
    j. Fills: 95 percent.

C. Excavation:
1. Under footings:
    a. Restore to the proper elevation using one of the following:
        1) Aggregate base course.
        2) Controlled low-strength material.
    b. Excavation width:
        1) Extend excavations at least 0.5:1 below the bottom of the structure, but not less than 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
        2) Do not undercut slopes.
    c. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.

2. Excavation of lined channels:
    a. Excavations in open cut for lined channels may be made so as to place concrete directly against excavated surfaces providing faces of excavations are:
        1) Firm and unyielding.
        2) Will stand or can be made to stand without sloughing.
    b. Excavations to provide subgrade for lined channel or subdrainage material: Excavate to lines and grades indicated on the Drawings.
3. Excavation of unlined channels and basins:
    a. Excavate to lines and grades indicated on the Drawings.
    b. Perform excavation and grading so that finish surfaces are in uniform planes with no abrupt breaks in surface.
4. Excavation of ditches and gutters:
    a. Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
    b. Take care not to excavate ditches and gutters below grades indicated on the Drawings.
    c. Backfill excessive ditch and gutter excavations to grade with suitable material acceptable to the Engineer.
    d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.
5. Necessary over excavation:
    a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
    b. Backfill voids with material acceptable to the Engineer:
        1) With acceptance of the Engineer, backfill with one of the following:
            a) Aggregate base course.
            b) Controlled low-strength material.

D. Materials for backfills, embankments, fills, and roadway fills:
1. General:
    a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within Project site do not conform to specified requirements or are not sufficient in quantity for construction of Project.
2. Backfills:
    a. Backfill adjacent to structures, slabs, or walls: Native material or imported material meeting the requirements of native select material, unless otherwise specified or indicated on the Drawings.
    b. Backfill material under concrete structures: Aggregate base course material, except in areas where controlled low-strength material or concrete encasement are indicated on the Drawings.
    c. Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
3. Embankments:
    a. Native material or imported material meeting the requirements of native select material, unless otherwise specified or indicated on the Drawings.

4. Fills:
    a. Native Select material or imported material meeting the requirements of native select material, unless otherwise specified or indicated on the Drawings.
    b. Extend fill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
5. Roadway fills: One of the following, unless otherwise specified or indicated on the Drawings:
    a. Aggregate base course material.
    b. Native Select material or imported material meeting the requirements of native select material.

E. Placement:
1. General:
    a. Lines and grades:
        1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
        2) Overbuild permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
2. Backfills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 2 percent above optimum moisture content before compacting.
    c. Defective compacted backfills: Remove and recompact.
3. Fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 2 percent above optimum moisture content before compacting.
    c. Defective compacted fills: Remove and recompact.
4. Embankments:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 2 percent above optimum moisture content before compacting.
    c. Defective compacted embankments: Remove and recompact.
5. Roadway fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 2 percent above optimum moisture content before compacting.
    c. Defective compacted roadway fills: Remove and recompact.

3.04 FIELD QUALITY CONTROL

A. Confirmation tests:
1. Contractor's responsibilities:
    a. Adequacy of compaction equipment and procedures:
        1) Demonstrate adequacy of compaction equipment and procedures.

2) At each test location include tests for each type or class of backfill from bedding to finish grade.

b. Compaction sequence requirements:
1) Do not perform additional earthwork of the same kind until specified degree of compaction has been demonstrated.

c. Cost of confirmation tests: Paid for by the Contractor.

d. Qualifications of Contractor's testing laboratory: Acceptable to Engineer.

e. Copies of confirmation test reports: Submit promptly to the Engineer.

2. Frequency of confirmation testing:
a. Maximum dry density versus moisture:
1) Backfill: minimum of 1 every 50 cubic yards.
2) Cuts: minimum of 1 every 100 cubic yards.
3) Embankments: minimum of 1 every 200 cubic yards.
4) Fills: 50 cubic yards.
5) Roadway fills: 50 cubic yards.

b. Cost of confirmation tests:
1) Paid for by the Contractor.

c. Qualifications of Contractor's testing laboratory:
1) Perform confirmation testing by soils testing laboratory acceptable to the Engineer. Copies of confirmation test reports: Submit promptly to the Engineer.

B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.

b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.

2. Unlined channels and basins:
a. In both cut and fill, and levee and access roadside slopes in cut: Vertical tolerance of none above and 3 inches below grade indicated on the Drawings on bottom and side slopes.

b. On top surface of levee and access road in both cut and fill, and levee and access roadside slopes in fill: Vertical tolerance of none below and 3 inches above grade indicated on the Drawings.

3. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6 inches deep.

b. Intent of proceeding is to avoid sandy or gravelly areas.

4. Finish grading of surfaces:
a. Reasonably smooth, compacted, and free from irregular surface changes.

b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.

c. Uniformly grade areas that are not under concrete.

d. Finish ditches and gutters so that they drain readily.

C. Compliance tests:
1. Frequency of testing: Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
   1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
   1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
   1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 02312

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controlled low strength material (CLSM), also known as "flowable fill."

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 229R - Report on Controlled Low-Strength Materials.
   2. 301 - Specifications for Structural Concrete.

B. ASTM International (ASTM):
   1. C33 - Standard Specification for Concrete Aggregates.
   2. C94 - Standard Specification for Ready Mix Concrete.
   3. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
   4. C150 - Standard Specification for Portland Cement.
   5. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   6. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   7. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3).
   8. 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)).
   9. D4832 - Standard Test Method of Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   10. D5971 - Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material.
   11. D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material.

1.03 SUBMITTALS

A. Product data: Submit data completely describing materials in the mix and demonstrating compliance with the requirements of this Section.
   1. Cement: Mill tests. Indicate alkali content representative of each shipment.
   2. Fly ash: Identify source and type of fly ash.
   3. Water: Identify source and quality if not from a municipal treatment source.
   4. Admixtures: Manufacturer’s product data indicating suitability for use in CLSM mixes and recommended dosage rates.
   5. Aggregate:
      a. Submit source, type, and sieve analyses. Include testing to demonstrate that materials in accordance with ASTM C33 requirements.
      b. Resubmit at any time there is a significant change in grading of materials.

B. Mix design:
   1. Submit full details, including mix design calculations for mix proposed for use.
   2. Trial batch test data:
      a. Submit data for each test cylinder.
      b. Submit data that identifies mix and slump for each test cylinder.

1.04 DELIVERY, STORAGE AND HANDLING

A. Store or stockpile cement, fly ash, and aggregate in accordance with ACI 301.

B. Store admixtures in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Mixture of portland cement, water, pozzolan, fine aggregate and admixtures, proportioned in accordance with the recommendations of ACI 229 to produce a homogeneous mixture that is flowable, that will readily work into corners and angles; that will not segregate in the plastic state; and that is self-compacting at the time of placement without the use of mechanical vibration.

B. Performance requirements:
   1. Air content, total calculated in accordance with ASTM D6023: Not less than 8.0 percent, nor greater than 12.0 percent.
   2. Compressive strength, measured in accordance with ASTM D4832 at 28 days: Not less than 50 pounds per square inch, nor greater than 150 pounds per square inch.
   3. Wet density: Not greater than 132 pounds per cubic foot.
   4. Slump, measured in accordance with ASTM C143 at the point of placement: Greater than 9 inches and that allows CLSM to flow freely and to be self-compacting during placement.

2.02 MATERIALS

A. Cement:
   1. Portland cement in accordance with ASTM C150,Type II.
   2. Having total alkali content not more than 0.60 percent.

B. Fly ash: Class C or Class F fly ash in accordance with ASTM C618.

C. Water:
   1. Potable water: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.

D. Admixtures: Products of a single manufacturer, specifically manufactured or recommended by that manufacturer for use in CLSM.
   1. Air entraining admixture: In accordance with ASTM C260.
   2. Water reducing admixture: In accordance with ASTM C494, Type A.

E. Aggregate:
   1. Non-expansive, non-reactive, inert natural sand in accordance with ASTM C33 for fine aggregate.

2.03 MIXES

A. See Design and Performance Criteria for performance requirements of the plastic and hardened mix.

2.04 SOURCE QUALITY CONTROL

A. Trial batch:
   1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.
   2. Prepare trial batches using the specific cement, fly ash, admixtures, aggregates, and water proposed for the Work.
   3. Prepare trial batch with quantity sufficient to determine slump, workability, and consistency; and to provide test cylinders as indicated in this Section.

B. Trial batch testing:
   1. Determine slump in accordance with ASTM C143, with the following modifications:
      a. Do not rod the concrete material.
      b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.
   2. Prepare and test trial batch specimens in accordance with ASTM D4832, with the following modifications:
      a. Provide cylindrical test specimens, each 6-inches in diameter by 12-inch high.
      b. Provide a minimum of 8 cylinders for testing of each trial batch.
      c. Fill the molds to overflowing and tap sides lightly to settle the mix.
      d. Do not rod the mix for consolidation in the cylinder.
      e. Strike off the excess material.
   3. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   4. Do not remove the test cylinder from mold until that cylinder is to be capped and tested.
      a. Perform the capping carefully to prevent premature fractures.
      b. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.
   5. Provide compressive strength tests:
      a. Test 4 test cylinders at 7 days after casting, and another 4 cylinders at 28 days after casting.
      b. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

C. If the trial batch tests do not meet the Specifications for strength or density, revise and re-submit the mix design, prepare additional trial batch(es), and complete

additional trial batch tests. Repeat until an acceptable trial batch is that conforms to the Specifications is produced.

1. All the trial batches and acceptability of materials shall be paid by the Contractor.
2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not place CLSM until preparation and condition of surfaces receiving the fill have been observed and accepted by the Engineer.

B. Remove debris foreign matter, and standing or running water from excavations and areas receiving CLSM before placement.

3.02 INSTALLATION

A. Pipes and trenches.
   1. Install cellular concrete as indicated on the Drawings and specified.
   2. Where CLSM is placed around and over pipes, secure pipes in place, or place CLSM in lifts to prevent pipe flotation.
   3. Where CLSM is placed in long, open trenches, confine material using bulkheads of sandbags, earth dams, or stiffer concrete at open ends of placement.

B. Soil preparation:
   1. Prior to placement of CLSM, prepare underlying soils as follows:
      a. Scarify surface to a depth of 8 inches.
      b. Adjust moisture content to or slightly above the optimum in accordance with ASTM D1557.
      c. Re-compact scarified surface to a minimum of 95 percent relative density in accordance with ASTM D1557.

3.03 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measure, batch, mix and transport CLSM in accordance with the requirements of ASTM C94 and this Section.

B. Mix until there is uniform distribution of materials.

C. Discharge mixer completely prior to recharging.

D. After trial batch testing and mix acceptance, maintain slump during construction within plus or minus 1 inch of the design slump.

3.04 PLACING

A. Place controlled low strength material by method that preserves the quality of the material in terms of compressive strength and density.

B. Maintain fluid properties of the mix during placement.
   1. At point of placement, provide material that flows easily around, beneath, or through walls, pipes, conduits, or other structures.
   2. Do not place CLSM that has partially hardened or that has been contaminated by foreign materials.
   3. Handle and place CLSM using methods that minimize segregation of the mix.
   4. Deposit mix as near its final position as possible to avoid segregation due to rehandling or flowing.
   5. Contain and confine mix while it is fluid. Design containment structures and bracing at walls and forms to withstand lateral pressures of wet mix.

C. Lifts:
   1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings.
   2. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent additional lateral load against the forms or structure due to the weight of the next lift of CLSM.

D. Water conditions:
   1. Do not place CLSM in standing or flowing water.
   2. Do not permit water to flow over the surface of freshly placed or un-hardened CLSM.
   3. Do not submerge CLSM in water within 24 hours after placement.

E. Manage CLSM bleed water.
   1. Grade top surface of CLSM to drain away from the fill.
   2. Provide side containment that permits bleed water to drain to a contained management area away from the fill.

3.05 CURING AND PROTECTION

A. Curing:
   1. Prior to and during curing, install barriers to prevent equipment or personnel from falling into or becoming entrapped in CLSM.

B. Protect CLSM from:
   1. Damage from the elements.
   2. Damage of any nature during surrounding construction operations.
   3. Freezing: Do not use salt, manure, or other chemicals to provide protection from cold temperatures.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01450 - Quality Control and Section 01460 - Contractor Quality Control Plan and as specified in this Section.

B. General:
   1. Engineer observation and acceptance required prior to placement.
   2. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Owner's Testing Laboratory in preparing said specimens.

3.07 FIELD QUALITY ASSURANCE

A. Provide quality control over the work of this Section as specified in Section 01450 - Quality Control and Section 01460 - Contractor Quality Control Plan.

B. Field observations:
   1. Engineer shall provide on-site observation for the Work of this Section.
   2. Advise Engineer of readiness to proceed at least 24 hours prior to each placement of CLSM.
   3. Required observations:
      a. Engineer will observe the prepared areas. Do not place CLSM until Engineer has observed and accepted preparations.
   4. Record of observations.

C. Field sampling and testing:
   1. During construction, Contractor shall provide sampling and testing to determine whether the CLSM, as produced and placed, complies with the requirements specified.
   2. Sample CLSM for testing in accordance with ASTM D5971.
   3. Required tests:
      a. Air content: Prepare sample and test in accordance with ASTM D6023.
      b. Compressive strength: Prepare and test cylinder specimens in accordance with ASTM D4832.
         1) Prepare 6-inch diameter by 12-inch high specimens for testing.
            a) Provide one set of specimens for each 150 cubic yards of CLSM placed, but not less than 1 set for each half day's placement.
            b) Prepare and test not less than 3 cylinders for each set.
            c) Place CLSM in the molds in accordance with ASTM D4832. Do not rod or otherwise consolidate the material in the mold.
            d) In accordance with ASTM D4832 recommendations for displacing bleed water at the top of the molds and refilling the molds before covering with a lid. Do not use air-tight lids.
         2) Place the cylinders in a safe location away from construction activities.
            a) Protect cylinders from bumping and impact.
            b) Maintain temperature surrounding cylinders between 60 and 80 degrees Fahrenheit until delivery to the laboratory for testing.
            c) After the first day, surround molds with a high humidity environment by covering with wet burlap, or equivalent highly

absorptive material. Maintain saturation of the cover. Do not sprinkle water directly on the cylinders.

3) After 4 days, place the cylinders in a protective container for transport to the laboratory for testing.
    a) Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
    b) Transport container may be a box with a Styrofoam or similar lining that will limit jarring and bumping of the cylinders.
4) Upon receipt at the testing laboratory, place test cylinders in a moist curing room until dates for testing.
5) Do not remove test cylinders from molds until the day that cylinders is to be capped and tested.
6) Cap and test for compressive strength in accordance with ASTM D4832.
    a) Do not perform initial compression test until the cylinders reach an age of at least 4 days.
    b) Test 1 cylinder at 7 days and 2 at 28 days.
7) Compressive strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength specified.

3.08 NON-CONFORMING WORK

A. When testing or observation indicates CLSM with properties outside the specified and accepted range, Engineer will issue instructions regarding disposition of nonconforming materials.

B. Engineer may:
    1. Reject CLSM represented by those test specimens and require its removal and replacement.
    2. Require modification of the mix design to provide CLSM with the properties specified.

C. Make such modifications at no additional expense to the Owner and with no adjustment to the schedule.

END OF SECTION

SECTION 02318

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Trench excavation and trench backfill for pipelines, manholes, vaults, and appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).
   2. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Backfill: Material placed in trench above the pipe embedment zone.
   2. Bedding: Material placed under, around, and over pipes or ducts in trenches.
   3. Fine grading: Bedding material placed directly below pipes or ducts to provide support at the bottom of the trench and to bring those elements to required grades and elevations.
   4. Flexible pipe: Includes steel, ductile iron, thermoplastics such as polyvinyl chloride (PVC) and high-density polyethylene (HDPE), thermosetting plastics such as fiberglass-reinforced polymer (FRP), bar-wrapped concrete cylinder pipe, and corrugated steel pipes.
   5. Haunch zone: Material placed below and beside the pipe up to the pipe springline.
   6. Lift: A layer of soil or aggregate material, measured before compaction.
   7. Maximum density, Field Compaction: Soil density and water content when tested in accordance with ASTM D6938.
   8. Maximum density, Laboratory Compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D6938.
   9. Pavement section: Includes pavement plus underlying courses such as base course and subgrade.
   10. Pipe embedment zone: Includes bedding, fine grading, and haunch zone.
   11. Pipe foundation: Material placed at the bottom of trench to provide support.
   12. Pipe foundation: Stabilization material placed at the bottom of trench to provide support when the trench bottom is not firm, dry or uniform.
   13. Pipe springline: A horizontal reference line located at mid-height, or halfway point, of a circular conduit, pipe, or tunnel. It is the maximum horizontal dimension or diameter of a circular conduit, pipe, or tunnel.

14. Rigid pipe: Includes reinforced non-cylinder concrete, reinforced concrete cylinder, prestressed concrete cylinder, vitrified clay, polymer concrete, cast iron, asbestos cement and cast-in-place pipes.

1.04 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures.

B. Product data on soils and aggregates.
   1. Material source.
   2. Gradation.
   3. Test data to demonstrate compliance with requirements as specified in this Section.

C. Samples:
   1. Provide 50-pound sample of materials when requested by the Engineer.

D. Confirmation testing:
   1. Certification of Contractor's testing laboratory.
   2. Record copy report for tests performed by Contractor's testing laboratory.

PART 2 PRODUCTS

2.01 MATERIALS

A. As specified in Section 02050 - Soils and Aggregates for Earthwork.

B. Class C concrete: As specified in Section 03300 - Cast-in-Place Concrete.

C. Controlled low-strength material: As specified in Section 02312 - Controlled Low Strength Material (CLSM).

PART 3 EXECUTION

3.01 PREPARATION

A. Stabilize excavations as specified in Section 02260 - Excavation Support and Protection.

B. Locate and verify existing utilities prior to any excavation.

3.02 TRENCH EXCAVATION

A. Excavate bottom of trench to depth indicated on the Drawings.

B. Areas of new fill or embankment:
   1. Prior to laying pipes or electrical service, place fill and compact as specified to not less than 2 feet above top of pipe, conduit, or duct bank.
   2. Excavate through fill for pipe trench.

C. Trench widths as specified in the following table:

Buried Pipe or Accessory	Minimum Trench Width	Maximum Trench Width
Nominal Pipe Diameter: 4-inch to 24-inch	OD + 18 inches	OD + 24 inches
Nominal Pipe Diameter: Greater than 24-inch	OD + 24 inches	OD + 36 inches
Manholes, vaults, valves, or other accessories	12 inches between outer surface and trench side or shoring	Not applicable

D. Potable water pipe and appurtenances:
   1. Lay in trenches separate from those used for sewers and recycled water.
   2. Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground located at distance of not less than 10 feet clear horizontally from any parallel sewer and 1.5 feet clear vertically above any parallel sewer.

E. At road crossings or existing driveways:
   1. Provide notification, vehicular access, and traffic control as required by permits and special conditions.
   2. Provide temporary asphalt or plating for traffic or access at the end of each workday unless approved in writing by the Engineer.
   3. If unexpected utility conflicts or changed site conditions require trenchless technologies or temporary bridges, immediately notify the Engineer in writing. Approval is required before proceeding with construction.
   4. When trench width at top of pipe is increased beyond width specified in this Section because of soil conditions, safety requirements, or other reasons, Engineer approval for remedy is required without additional cost to the Owner.
      a. Remedy may include upgrade laying conditions or install stronger pipe designed in accordance with Specifications.

3.03 TRENCH BACKFILL - GENERAL

A. Trench area terminology and locations as indicated on the Drawings.

B. Place material, except CLSM and concrete, in maximum 6-inch lifts, measured before compaction.

C. Backfilling of manhole excavation: Conform to backfilling requirements for trenches as specified in this Section.

3.04 PIPE FOUNDATION

A. Provide trench bottom with firm, dry, uniform bearing surface at the grade indicated on the Drawings.

B. Excess excavation below elevation indicated on the Drawings will require installation of pipe foundation material to bring the trench bottom back to the elevation indicated on the Drawings at no additional cost to the Owner.
   1. Materials and placement:
      a. Stabilization material:
         1) Wrap stabilization material as specified in Section 02621 - Stabilization Fabric.

C. If bottom of trench excavation consists of soil:
   1. Scarify bottom of trench to a depth of 6 inches below the grade indicated on the Drawings.
   2. Materials and placement:
      a. Recompact scarified material to 95 percent of maximum density.

D. If bottom of trench excavation consists of rock or any material that, by reason of its hardness, cannot be excavated to provide uniform bearing surface:
   1. Remove such rock or other material to a depth of not less than 4 inches below pipe embedment zone.
   2. Materials:
      a. CLSM.
      b. Class C concrete.

E. If bottom of trench excavation consists of mud or other soft unstable material:
   1. Remove such unacceptable material to a depth of not less than 12 inches below pipe embedment zone.
   2. Material and placement:
      a. Stabilization material:
         1) Wrap stabilization material as specified in Section 02621 - Stabilization Fabric.

3.05 PIPE EMBEDMENT ZONE

A. Pipe displacement:
   1. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
   2. In event there is movement or floating of the piping, re-excavate, re-lay, and backfill the pipe.

B. Fine grading:
   1. Place 6 inches of approved haunch zone bedding material from the trench bottom to the bottom of the pipe or duct to provide support at the bottom of the trench and to bring those elements to required line and grade.

C. Depressions for joints or couplings:
   1. Excavate holes in the fine grading material at the bottom of the trench.
   2. Provide holes of sufficient width to provide ample room for grouting, banding, or welding as necessary for making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.

D. Rigid pipe:
    1. Pipe embedment zone: Below pipe springline:
        a. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.
            2) Select material compacted to 95 percent maximum dry density.
    2. Pipe embedment zone: Above pipe springline:
        a. Compacted to a depth above pipe: 12-inch minimum.
        b. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.

E. Flexible pipe:
    1. Pipe embedment zone:
        a. Compacted to a depth above pipe: 12-inch minimum.
        b. Materials and placement:
            1) Aggregate base course compacted to 95 percent maximum dry density.

3.06 BACKFILL

A. Trenches:
    1. Materials and placement:
        a. Native soil - select compacted to 95 percent maximum dry density.
        b. Imported fill compacted to 95 percent maximum dry density.
        c. Aggregate base course compacted to 95 percent maximum dry density.
        d. CLSM.

B. Trenches in rock:
    1. Backfill to top of rock.
        a. Materials and placement:
            1) CLSM.
            2) Class C concrete.
    2. Backfill from top of rock to grade, if applicable:
        a. Materials and placement:
            1) Aggregate base course compacted to 95 percent of maximum density.

C. Trenches below or within 10 feet of the outside perimeter of structures:
    1. Backfill to underside of structural fill below structure, as specified in Section 02300 - Earthwork.
    2. Materials and placement:
        a. Aggregate base course compacted to 95 percent of maximum density.
        b. CLSM.

D. Trenches in roadways and paved areas:
    1. Backfill trench to underside of pavement.
    2. Materials and placement:
        a. Aggregate base course compacted to 95 percent of maximum density.
        b. CLSM.

E. Trenches in areas outside the improved section of roadways or in open country:
   1. Backfill to underside of topsoil layer.
   2. Materials and placement:
      a. Native soil - select, imported material, or aggregate base course compacted to 90 percent of maximum density.

F. Trenches under existing intersecting pipes, duct banks, or conduits larger than 3 inches in diameter:
   1. Backfill from above top of new pipe embedment zone to springline of intersecting pipe or conduit.
      a. Extend backfill at least 2 feet on either side of intersecting pipe or conduit to ensure backfill material remains in place while other backfill is being placed.
      b. Materials and placement:
         1) CLSM, unless otherwise indicated on the Drawings.
   2. Backfill remainder of trench:
      a. Materials and placement:
         1) CLSM.

3.07 EXCESS MATERIAL

A. Remove excess excavated material from the Project site as specified in Section 02300 - Earthwork.

3.08 FIELD QUALITY CONTROL

A. Provide field quality control for the Work as specified in Section 01450 - Quality Control.

B. Confirmation tests: As specified in Section 02300 - Earthwork.
   1. Minimum frequency of confirmation testing:
      a. At each test location include tests for each type or class of backfill from bedding to finished grade.
      b. For trenches: 1 location every 100 linear feet.
      c. In open fields: 2 locations every 500 linear feet or 1 location every 100 cubic yards. Along dirt or gravel road or off traveled right-of-way: 1 location at every 200 linear feet.
      d. Crossing paved roads: 1 location at each crossing.
      e. Under pavement cuts or within 2 feet of pavement edges: 1 location every 100 linear feet.

C. Compliance tests:
   1. Make periodic compliance tests to verify that compaction is meeting requirements as specified in this Section.
   2. Perform remedial work if compaction test fails to meet specified requirements using one of the following methods:
      a. Remove and replace backfill at the proper density.
      b. Other means acceptable to the Engineer.

3. Retesting:
    a. Costs of retesting: Contractor is responsible for the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
    b. Contractor's confirmation tests during performance of remedial work:
        1) Performance: Perform tests in manner acceptable to the Engineer.
        2) Frequency: Double amount specified for initial confirmation tests.

D. Piping system testing:
    1. As specified in Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 02370

RIPRAP AND GABIONS EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plain, and grouted riprap.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C150 - Standard Specification for Portland Cement.

1.03 SUBMITTALS

A. Product data.

B. Installation instructions.

PART 2 PRODUCTS

2.01 PLAIN RIPRAP

A. Material: Rock, broken concrete from site preparations, or wasted concrete from project pours.

B. Size and weight: 1/8 cubic to 1 cubic foot and 20 to 150 pounds, except small stones and spalls used to chink interstices shall weigh not less than 10 pounds and at least 50 percent of pieces shall weigh not less than 100 pounds.

C. Material shapes:
   1. Capable of forming stable protection structure of required depth.
   2. Rounded boulders or cobbles on 2:1 slopes and less.
   3. Angular.
   4. Flat or needle shapes with thickness more than 1/3 length.

2.02 GROUTED RIPRAP

A. Material: Rock, broken concrete from site preparation, or wasted concrete from job pours, 1/8 to 1 cubic foot 20 to 150 pounds.

B. Cement: In accordance with ASTM C150, Type II.

C. Aggregate:
   1. Fine: Sand.
   2. Coarse: Gravel passing 3/8-inch square mesh screen.

D. Water: Clean.

E. Grout mix:
   1. Hand mix when acceptable to the Engineer or machine mix. 1 part cement, 2 parts fine aggregate, and 1 part coarse aggregate by volume, with water as required and acceptable to the Engineer to permit gravity flow of grout into interstices with limited spading and brooming.
   2. When hand mixing, thoroughly mix cement and aggregate in clean, tight mortar box until mixture is of uniform color, then add water in such quantity as to provide a grout of specified consistency.
   3. When machine mixing, mix in accepted machine for not less than 1-1/2 minutes.

PART 3 EXECUTION

3.01 PREPARATION

A. Shape and trim bed for riprap as required to provide even surface which at no point is higher than design surface.

B. Grade slopes on which sacked concrete riprap or gabions are to be placed to tolerance of 0.00 to minus 0.20 foot.

C. Excavate footing trench along toe and cutoff trench at top of slope, as indicated on the Drawings.

3.02 PLACING PLAIN RIPRAP

A. When required riprap is less than 20 inches in depth, place material by hand.

B. When riprap is 20 inches or more in depth, place material by dumping and spreading in layers by bulldozers or other suitable equipment.

C. Place material to provide minimum of voids.

D. Place larger pieces in toe of trench, foundation course, and on outer surface of riprap.

E. Place pieces with their longitudinal axis normal to face of embankment and so arranged that each piece above the foundation course has minimum 3-point bearing on underlying stones.
   1. Bearing on smaller pieces used to fill voids will not be acceptable.

F. Fill interstices between pieces with small pieces and spalls.

3.03 PLACING GROUTED RIPRAP

A. Place material in manner to provide minimum of voids.

B. Place larger pieces in toe trench, foundation course, and on outer surface of riprap.

C. Place pieces with their longitudinal axis normal to face of embankment and so arranged that each piece above foundation course has at least a 3-point bearing on underlying material.
   1. Fill interstices between pieces with small pieces and spalls. Bearing on smaller pieces used to fill voids will not be acceptable.

D. Grout with grout mix specified for grouted riprap.

3.04 TOLERANCES

A. Finished surfaces of riprap for plain or grouted riprap: Within 3 inches per foot of depth.

END OF SECTION

SECTION 02581

PRECAST ELECTRICAL HANDHOLES AND ELECTRICAL MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Design, fabricate, and install precast electrical handholes and precast electrical manholes of the size and type indicated on the Drawings and specified.
   1. Construction of cast-in-place concrete electrical structures, including handholes and manholes, are specified in other sections.

B. Section includes:
   1. Precast polymer concrete handholes and accessories.
   2. Precast portland cement concrete handholes and accessories.

C. Alternates:
   1. Contractor may propose to construct cast-in-place structures in lieu of the precast structures specified.
      a. Obtain Engineer's acceptance of this alternative before submitting, providing, or installing.
      b. Submit full information on design and detailing of proposed alternatives including design details and drawings of the same types required by this Section for precast structures.

1.02 REFERENCES

A. American Association of State Highway Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C858 - Standard Specification for Underground Precast Concrete Utility Structures.
   4. C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
   5. C1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   6. C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

D. National Fire Protection Association (NFPA):
   1. National Electrical Code (NEC).

E. National Precast Concrete Association (NPCA).

F. Society of Cable Telecommunications Engineers (SCTE):
   1. 77 - Specification for Underground Enclosure Integrity.

G. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Handhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to reach into, but not enter, the enclosure to install, operate, or maintain equipment or wiring or both. (Reference: NEC, Article 100)
   1. As used in this Section, “handhole” will refer to a precast electrical handhole.

B. Manhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to enter the enclosure to install, operate, or maintain equipment or wiring or both.
   1. As used in this Section, “manhole” will refer to a precast electrical manhole.

C. Polymer Concrete: A composite material consisting of an organic polymer binder mixed with embedded aggregate particles. Also known as “resin concrete.”

D. Portland Cement Concrete: A composite material consisting of a portland cement binder, water, admixtures, and a combination of fine and coarse mineral aggregates.

E. Precast Concrete: A concrete fabrication designed by a qualified engineer and subsequently fabricated at a qualified fabrication site, which is usually located some distance from the site where the fabrication will be installed.

1.04 SUBMITTALS

A. Product data: Manufacturer’s catalog data, details, and warranties for the following items.
   1. Polymer concrete handholes:
      a. Materials of construction, and resistance of those materials to water absorption, flammability, sunlight/ultraviolet exposure, and chemicals likely to be found in the area of use.
      b. Available colors.
      c. Details for covers, cover support, and cover attachment to the underlying box.
   2. Portland cement concrete handholes and manholes:
      a. Materials of construction.
      b. Joint details and joint-sealing materials.
      c. Data for hatches or covers and rings.
      d. Preformed channels and accessories for cable racking.
      e. Drain and sump details, including removable covers.
      f. Pulling iron details.

B. Shop drawings:
    1. Polymer concrete handholes:
        a. Manufacturer's catalog cuts showing dimensions and details of construction.
    2. Portland cement concrete handholes and manholes:
        a. Shop drawings for each structure shall bear the seal and signature of a professional structural engineer licensed in the state where the structures will be installed.
        b. Dimensioned and "to-scale" plans, sections, and details for each structure including:
            1) Layout plan for that structure.
            2) Sizes, locations, and vertical positions of duct bank windows and knockout panels.
            3) Locations and details for access openings, pulling irons, embedded cable supports and racks, and sumps.
            4) Details of structural reinforcement showing bar size and spacing; true position of reinforcement in structural members with clear concrete cover at both inside and outside faces; location, bar size, and spacing of added reinforcement around openings; and other details relevant to design and fabrication of the structure.
            5) Details of joints between adjacent precast sections, including provisions for overlap and for placement of sealants.

C. Design data:
    1. Polymer concrete handholes:
        a. ANSI/SCTE 77 - Tier 22, WUC 3.6
    2. Portland cement concrete handholes and manholes:
        a. Structural calculations:
            1) Submit complete structural calculations for each structure.
            2) Provide calculations bearing the seal and signature of a professional engineer licensed in the state where the structures will be installed.
            3) Calculations will be filed for record. Review comments will not be returned.
        b. Manufacturer's statement of materials used for fabrication and construction, in accordance with ASTM C858, for record. Include the following:
            1) Concrete mix design: For each concrete mix design to be used for the structures, include data describing:
                a) Source and type of cement.
                b) Sources, grading, and specific gravities of aggregates.
                c) Aggregate reactivity data.
                d) Concrete mix proportions and design strength.
                e) Type, name, and dosage of admixtures included in the concrete mix.
            2) Reinforcing steel: Mill certificates.

D. Test reports:
    1. Polymer concrete handholes:
        a. Independent laboratory test reports bearing the seal of a licensed professional engineer and demonstrating compliance with the requirements of SCTE 77 for the loading conditions specified.

2. Portland cement concrete handholes and manholes:
    a. Fabricator's tests for compressive strength of concrete used in structures, made in accordance with recommendations of ASTM C858.

E. Certificates:
1. Polymer concrete handholes:
    a. Manufacturer's certification that polymer concrete handholes are in accordance with the requirements of SCTE 77.
2. Portland cement concrete handholes and manholes:
    a. Manufacturer's current plant certification under NPCA for the structures to be supplied.
        1) Certification shall be current and in-effect at the time structures are manufactured.
    b. Manufacturer's certification that handholes and manholes are in accordance with the requirements of ASTM C858.

F. Manufacturer's instructions:
1. Instructions for handling and setting structures in place.
    a. Polymer concrete handholes
    b. Portland cement concrete handholes and manholes:
        1) Instructions for operation and maintenance of hatches.

G. Manufacturer's field reports:
1. Portland cement concrete handholes and manholes:
    a. Manufacturer's inspection reports in accordance with ASTM C1037.

H. Closeout documents:
1. Project record documents:
    a. Portland cement concrete handholes and manholes:
        1) Final, revised plans and details of as-constructed precast handholes and manholes if requested for record by the Engineer.
2. Warranties:
    a. Manufacturer's standard warranty for:
        1) Polymer concrete handholes.
        2) Portland concrete handholes and manholes and accessories.

1.05 QUALITY ASSURANCE

A. Qualifications:
1. Designer:
    a. Portland cement concrete handholes and manholes:
        1) Professional structural engineer qualified in the design of concrete structures and holding a current license in the state where the structures will be installed.
2. Manufacturer:
    a. Polymer concrete handholes:
        1) Demonstrating at least 5 years of experience in the design and production of products of the type required for this Work.
        2) Holding product testing records demonstrating load resistance of products to be installed.

b. Portland cement concrete handholes and manholes:
    1) Holding current NPCA plant certification for the products produced.
    2) Demonstrating at least 5 years of experience in the design, production, and installation of products of the type required for this Work.
    3) Capable of providing structural designs prepared by a professional engineer licensed in the state where the structures will be installed.
    4) Providing inspection during fabrication and handling in accordance with the requirements of ASTM C1037.

3. Installer:
    a. Capable of providing equipment of adequate capacity and mobility to handle and set units with proper bearing on the subgrade and without damage to the unit.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, handling, and unloading:
    1. Package and brace structures to avoid damage during shipping and handling.
    2. Furnish crane or forklift for unloading and setting of portland cement concrete handholes and manholes.

B. Acceptance at site:
    1. Structures delivered to the site with cracks, damage, and damaged or missing accessories shall be removed from the site and replaced at no additional cost to the Owner.

C. Storage and protection:
    1. Store handholes and manholes and their appurtenances in areas protected from damage due to weather and site operations.

1.07 PROJECT CONDITIONS

A. Operating environment: As specified in Section 01850 - Design Criteria

1.08 SEQUENCING

A. Coordinate installation of precast electrical handholes and manholes with duct banks specified in Section 16133 - Duct Banks.

1.09 WARRANTY

A. Provide manufacturer’s standard warranty for precast handhole and manhole structures and accessories.

1.10 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS - POLYMER CONCRETE HANDHOLES

A. General:
   1. Enclosures, boxes, and cover shall conform to test provisions of SCTE 77.

B. Manufacturers: One of the following or equal.
   1. Quazite Division of Hubble, Incorp.
   2. Carson Ind., LLC.

C. Materials:
   1. Polymer concrete with optional fiberglass reinforcement.
      a. Handholes constructed of plastic or fiberglass will not be permitted.

D. Components:
   1. Cover:
      a. Provide gasketed cover with lifting slot and stainless steel hex head bolts for attachment to box.
      b. Fasten cover to box using stainless steel hex head bolts.
      c. Skid-resistant surface: Coefficient of friction for walking surface on top of cover shall be at least 0.50 when measured in accordance with ASTM C1028.
      d. Custom logo not required.
   2. Box:
      a. Open-bottom base unless otherwise indicated on the Drawings.
         1) Stackable sections with interlocking joints to maintain horizontal and vertical alignment.
      b. Provide knockouts, terminators, pulling eyes, and inserts as required for a complete installation.
   3. Fabrication:
      a. All components in assembly (boxes and cover) shall be manufactured using matched surface tooling for consistency of production.

E. Load rating:
   1. Provide “TIER” rating based on Schedule of Electrical Handholes and Electrical Manholes indicated on the Drawings, and the following loading requirements:

Surface Loading Rating	Requirements
“Sidewalk”	“TIER 15” - “Medium Duty” For driveway, parking, and ramp areas where vehicle wheel loads will not exceed 2,000 pounds on a single wheel.
“Roadway”	Not allowed. - “Heavy Duty” For highway traffic or AASHTO wheel loads of at least 16,000 pounds.

   2. Provide covers with “TIER” rating embossed or cast into the top surface.

3. Design load rating of cover for an assembly may not exceed the design load rating of the box below.

F. Accessories:
   1. Provide 2 non-corroding steel lifting hooks for removing covers.

2.02 MANUFACTURED UNITS - PORTLAND CEMENT CONCRETE HANDHOLES AND MANHOLES

A. General:
   1. Provide portland cement concrete handholes and manholes configured and designed as indicated on the Drawings and specified.
   2. In accordance with ASTM C858 unless otherwise noted.
      a. Concrete: Provide units with minimum specified compressive strength (f'c) of 5,000 pounds per square inch and using Type II cement.

B. Manufacturers: One of the following, or equal:
   1. Oldcastle Precast.
   2. Jensen Precast.

C. Components:
   1. Floor:
      a. Construct floors as a monolith.
      b. Where sump or low-point drain is included, slope floor to that point.
   2. Roof, walls, and base:
      a. Designed and rated to support vehicle and pedestrian loads at the spans indicated.
      b. See the Electrical Handhole and Manhole Schedule indicated on the Drawings for required load rating by structure location.
   3. Access covers:
      a. Handholes: Aluminum plate hinged floor access door (hatch) as specified in Section 08320 - Floor Access Doors.
         1) Load rating:
            a) "Heavy Duty" for covers at locations designated for "Roadway" loads.
            b) "Medium Duty" or stronger for covers at locations designated for "Sidewalk" loads.
         2) Minimum access door size not less than 36 inches square, unless otherwise indicated on the Drawings.
         3) Provide bearing surface with pre-installed continuous elastomeric gasket to minimize water infiltration at lid.
         4) Provide skid-resistant lid with cast-in or machined-in grid pattern and the word "ELECTRICAL" in block letters at least 1.5 inches high.
      b. Manholes: Cast iron frame and cover:
         1) Manhole rings and covers: As specified in Section 05500 - Metal Fabrications.
         2) Manhole rings and covers:
            a) Gray cast iron in accordance with ASTM A48, Class 30B with ring and cover machined to fit with flat bearing surfaces.
            b) Cover with word "ELECTRICAL" cast into the top exposed face for electrical manholes.

c) Manhole riser access:
(1) Heavy-duty bottom flange frame with solid cover for placement on grade adjustment rings above top slab.
(2) 36-inch diameter nominal opening.
(3) Manufacturers: The following or equal.
(a) Neenah Foundry Co., R1640-D.

d) Embedded in top slab of structure:
(1) Heavy-duty top flange frame with solid cover for embedment in top slab of a structure.
(2) 36-inch diameter nominal opening.
(3) Manufacturers: The following or equal.
(a) Neenah Foundry Co., R6095.

D. Accessories:
1. Provide accessories as indicated on the Drawings and specified.
2. Materials at duct bank penetrations:
a. Joint filler as specified in Section 03150 - Concrete Accessories.
b. Backer rod and sealant as specified in Section 07900 - Joint Sealants.
3. Pulling irons:
a. Provide non-corroding cable pulling irons located for use with each current duct bank location and additional irons for use with duct banks that may be installed through future knockout panels.
b. Pulling irons may not be located on the floor.
c. Where pulling irons are installed on the wall, any pockets surrounding the irons shall have bottom surfaces sloped to drain.
d. Secure pulling eyes to structure reinforcement.
4. Cable racks and racking hardware:
a. Materials: Hot-dip galvanized steel as specified in Section 16070 - Hangers and Supports.
b. Embedded slots: Maximum depth of 1.5 inches.
5. Sumps and drains:
a. Fiberglass or HDPE fabrications including removable lids to prevent tripping hazards.
6. Exterior dampproofing:
a. As specified in Section 07110 - Dampproofing.
b. Field applied to wall and roof surfaces exposed to soil.

E. Fabrication:
1. Embeds:
a. Install embedded items with provisions for drainage to remove dripping or standing water, and to minimize corrosion.
1) Pulling irons may not be placed on the floor or in pockets that will collect water.
2) Detail bottom of cable rack channels to provide a downward sloping “sill” at the bottom of each vertical channel, so that the channel slot drains toward the floor.
b. Concrete cover:
1) Provide minimum 0.75-inch clear concrete cover between embeds and surrounding reinforcement.
2) Provide minimum 1.25-inch clear concrete cover between embed and exterior face of wall.

F. Tests and inspections:
   1. Test and inspect structures in accordance with ASTM C858 and ASTM C1037.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. General requirements for handholes and manholes:
   1. As specified in Section 16050 - Common Work Results for Electrical for general requirements for electrical work.
   2. Provide structures of the sizes and shapes indicated on the Drawings, with layouts, dimensions, and details as indicated on the Drawings and as specified.
   3. Conform to the requirements of:
      a. NEC.
      b. Project regulatory requirements as specified in Section 01410 - Regulatory Requirements.

B. Polymer concrete handholes:
   1. Load resistance of boxes and covers.
      a. Conform to provisions of SCTE 77 for Tier 5, 8, 15, or 22 applications as specified in this Section.
         1) Where multiple “Tiers” are specified, handholes shall adequately support compatible covers while providing the highest Tier rating specified.
         2) Load rating of cover for an assembly shall not exceed the load capability of the box below.
         3) Coefficient of friction between cover and box: Not less than 0.50 when measured in accordance with ASTM C1028.
   2. Testing and certification.
      a. Each handhole to be installed shall have a report certifying that the design and construction of the unit has successfully passed tests for materials and product performance required by SCTE 77.
         1) Testing and report shall be by a qualified testing agency, independent of the manufacturer. Test report shall bear the seal of a licensed professional engineer.
         2) Provide evidence of UL listing as required by NEC for products to be provided.

C. Portland cement concrete handholes and manholes:
   1. Load resistance of boxes and covers.
   2. Design requirements: Loads on structures:
      a. In accordance with ASTM C857, except as modified in this Section.
      b. Loads at the ground surface:
         1) See “Electrical Handhole and Manhole Schedule” indicated on the Drawings for minimum surface loading requirements at each structure. Loads are designated as “sidewalk,” or “roadway.”
         2) The vehicle and pedestrian loadings in the following paragraphs need not be additive; however, structures designated for “roadway” loading shall also support “sidewalk” loads.

3) “Sidewalk”: Load from regular pedestrian traffic with considerations for occasional non-deliberate vehicular traffic:
a) Designation "A-0.3" in ASTM C857 Table 1 (300-psf uniform load).
4) ”Roadway”: Load from heavy, frequently repeated vehicle traffic:
a) Designation "A-16" in ASTM C857 Table 1 (AASHTO HS20-44).

c. Lateral earth pressure loads:
1) Determine in accordance with the following requirements. Include effects of groundwater and seismic accelerations on lateral earth pressures.
a) Equivalent lateral pressure: 60 pounds per square foot per foot of depth (triangular distribution).
b) Surface surcharge load:
(1) Backfill-induced live load surcharge of 240 pounds per square foot (rectangular distribution).
(2) In accordance with ASTM C857 Vehicle Load Designation "A-16" for "Roadway" or "A-0.3" for "Sidewalk" where such surcharge exceeds backfill loads described in the preceding paragraph.
c) Seismic design:
(1) As specified in Section 01850 - Design Criteria.
(2) On opposite sides of the structure that are perpendicular to the direction of acceleration, include equivalent lateral pressure (inverted fluid pressure distribution), beginning with a pressure of 0 at the base of the structure, and increasing at a rate of 37.5 pounds per square foot per foot of rise toward the ground surface.
(3) Apply seismic effects as additive force on side where the soil mass is being accelerated toward the structure, and as subtractive force on the opposite side where the soil mass is being accelerated away from the structure.

d. Soil-bearing pressure at base:
1) Maximum 4000 pounds per square foot total pressure on prepared subgrade soils.
e. Lifting and handling loads:
1) Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.
f. Load combinations:
1) Design structures to sustain the specified loads individually or in combination.

3. Design requirements: Structural analysis, design, and detailing:
a. General:
1) Analyze and design structures including the effects of 2-way action (“plate action”) and of load transfer around current and future openings.
2) Where structures include panels designed for future removal (“knockout panels”), design structures for loads and stresses with any combination of any or all such panels in place or removed.

b. Precast polymer concrete handholes:
    1) Design to resist loads with cover in place or removed.
    2) Detail cover support and top edges to maintain cover in place over walls and to prevent soil from sloughing into the handhole when cover is removed.
c. Precast portland cement concrete handholes and manholes:
    1) Design structures in accordance with the requirements of ACI 318 and this Section.
    2) Provide reinforcement at areas subject to tensile stress when loaded with the specified loads and combinations thereof.
    3) Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in concrete sections.
    4) Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of members in accordance with the following:
        a) Handholes: 1.25 inches.
        b) Manholes: 2 inches.
    5) Reinforcement details:
        a) Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
        b) Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
        c) Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
    6) Joints:
        a) Provide structures with watertight joints between sections and detailed to minimize water infiltration at duct bank and conduit penetrations.
        b) Provide structures with non-skid, shiplap or tongue and groove joints between sections.

4. Design requirements: Materials:
    a. Polymer concrete handholes:
        1) In accordance with ASTM 6783 except as modified in this Section.
    b. Portland cement concrete handholes and manholes:
        1) In accordance with ASTM C858 except as modified in this Section.
        2) Proportion concrete mixes to resist damage from freezing and thawing in a moist environment, and for exposure to deicing chemicals. Conform to ACI 318 requirements for minimum specified compressive strength and air entrainment.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install precast electrical handholes and manholes as indicated on the Drawings and specified.

B. Install additional handholes and manholes required so installation procedures will conform to cable manufacturer's pulling tension requirements.
   1. Include proposed locations and details of such additional handholes and manholes with the submittals under this Section.

3.02 PREPARATION

A. Design:
   1. Prepare detailed and scalable layouts for each manhole structure showing locations of conduit or duct bank penetrations, clearances, locations, and sizes of access openings and major accessories.

B. Protection:
   1. Where handhole and manhole structures are installed adjacent to existing site structures or utilities, provide excavation support or other protection as required to maintain those facilities in service and to prevent damage to both existing and new facilities.

C. Site preparation:
   1. Excavate and prepare exposed subgrade as indicated on the Drawings and as specified.
   2. Install and compact foundation layer as indicated on the Drawings and specified.
   3. Level foundation materials so that structures will be set plumb, and duct banks will be at proper grade and alignment.
      a. Install with uniform bearing on foundation materials.
      b. Wedging or blocking of base sections for leveling over the foundation materials will not be permitted.

3.03 INSTALLATION

A. General:
   1. Protect handholes and manholes from displacement, flooding, or flotation.

B. Polymer concrete handholes:
   1. Install structures in accordance with the manufacturer's recommendations.
   2. Clean joints between adjacent sections for tight fit.
   3. Set covers at elevations indicated on the Drawings.
      a. Securely attach cover to below-grade box.
   4. Backfill polymer concrete handholes as indicated on the Drawings and as specified.

C. Portland cement concrete handholes and manholes:
   1. Install structures in accordance with ASTM C891 and the provisions of this Section.
      a. In the event of conflicts, the more restrictive provisions shall apply.
   2. Clean and prime joints between adjacent precast sections.
      a. Install sealing compound between sections and provide watertight joints.
   3. Set covers and hatches at elevations indicated on the Drawings.
      a. Securely attach frames to top of precast structures and grade adjustment rings.
   4. Penetrations:
      a. Holes for duct banks and other penetrations may not be cut into precast handholes and manholes unless they are located at designated locations shown on the shop drawings or at knockout panels cast into the structure during manufacturing.
      b. Carefully remove concrete from knockout panel areas with saws.
         1) Ensure that break-back does not extend beyond the designated limits of the knockout panel.
      c. Coat any reinforcement cut or exposed during removal of knockout panel sections with minimum 2 coats of high solids epoxy as specified in Section 09960 - High-Performance Coatings.
         1) Apply epoxy coating applied over and at least 1-inch past the perimeter of the reinforcement.
   5. Install duct banks and conduit penetrations in accordance with the penetration details indicated on the Drawings.
      a. Place joint fillers, caulks, and sealants before coating exterior concrete surface with bituminous dampproofing.
   6. Fill holes that were provided for handling or other temporary purposes with non-shrink cement grout using procedures as specified in Section 03300 - Cast-in-Place Concrete unless otherwise detailed by the manufacturer.
   7. After structures are set and before backfilling, coat exterior below-grade surfaces (around the sidewalls, over the top slab, and around any vertical risers to grade) with 2 heavy coats of bituminous dampproofing as specified in Section 07110 - Dampproofing.
      a. Apply dampproofing in accordance with the coating manufacturer's instructions and at a rate of 40 to 60 square feet per gallon per coat.
      b. Mask over at least 1 inch back from joint caulks or sealants and prevent dampproofing from coming in contact with those materials.
   8. Backfill handholes and manholes as indicated on the Drawings and as specified in Section 02300 - Earthwork.

D. Site tolerances:
   1. Set electrical handholes and manholes plumb and true at locations indicated on the Drawings.
   2. Tolerances on placing:
      a. Horizontal location: Plus or minus 1 inch.
      b. Vertical elevation: Plus or minus 1/2 inch.
      c. Plumb: Plus or minus 1/8 inch over 10 feet.

3.04 REPAIR/RESTORATION

A. Repair cracks or blemishes in concrete by methods acceptable to the Engineer. Submit proposed repairs for acceptance before commencing work.

3.05 ADJUSTING

A. After final grading is complete, adjust access covers to grade.

3.06 CLEANING

A. Before installation of cables in any duct banks and handholes or manholes, remove concrete spoil, forms, debris, silt, dust, and other foreign material.

B. Pressure wash interior of structures if required to provide clean interior surfaces.
   1. Block drains and provide pumps to remove washwater from structures.
   2. Do not permit washwater to drain into subgrade soils.

3.07 SCHEDULES

A. See Drawings for Electrical Handhole and Electrical Manhole Schedule.

END OF SECTION

SECTION 02600

CONCRETE MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Manhole frames and covers.
   2. Manhole grade rings.
   3. Manholes cones and risers.
   4. Manhole bases.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C150 - Standard Specification for Portland Cement.
   4. C443 - Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   5. C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
   6. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint.
   7. C923 - Standard Gide for In-Plant Performance Evaluation of Automatic Pedestrian SNM Monitors.
   8. C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

A. American Public Works Association (APWA), Utah Chapter
   1. 2017 Manual of Standard Specifications (Standard Specifications).

B. International Organization of Standardization (ISO):
   1. 9001 - Quality Management Standard.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Shop Drawings:
   1. Manufacturer’s catalog data and details of following items for approval:
      a. Frame and covers.
      b. Grade rings.
      c. Manhole cones and risers.

d. Manhole bases, if precast.
2. Manhole construction details, jointing methods, connection details, materials, and dimensions.
3. Repair procedures and details.

C. Calculations and criteria used in manhole design including material properties, loadings, load combinations, and dimensions assumed.

D. Test methods and results including certification that the manhole riser exceeds the minimum requirements in accordance with ASTM C478.

E. Sealed drawings and design calculations by a registered Professional Engineer licensed in the Utah where the project is located.

F. Certificates:
1. ISO 9001 certificate by a third party confirming that ASTM test reports are valid and up to date at the time of the bid and during construction period.
2. Manufacturer's Certificate of Source Testing.

1.04 PRODUCT REQUIREMENTS

A. As specified in Section 01600 - Product Requirements.

B. Provide suitable quantities of lifting equipment to handle the manholes/risers and castings.
1. In no case shall any equipment be used that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the manhole components.
2. Dragging or dropping the manhole components shall not be allowed.

C. Source Testing.
1. Perform pre-production and post-production tests by manufacturer staff with a minimum of 5 years of experience in quality control, inspection, and testing of manholes.
a. In lieu of this experience, witness of tests by up to 3 full-time Owner representatives.
2. Examine each completed manhole section for dimensional requirements, strength, and workmanship.
3. Complete required testing in accordance with ASTM C478.
4. Provide the Manufacturer's Certificate of Source Testing.

1.05 DESIGN CRITERIA

A. Manholes shall not include steps.

B. Manhole bases:
1. Constructed as part of the pipe installation or using tee risers.

C. Manhole riser:
1. Made of the same pipe material selected for the project, providing a sealed connection between the pipe base and riser as indicated on the Drawings.

2. Manufactured specifically for this project and no materials shall be furnished from stock unless approved by the Engineer.

D. Manhole provider shall coordinate with the pipe manufacturer for dimensions and connections.

E. Manhole systems:
   1. Provided by a single manufacturer.

F. Frames and covers:
   1. Provided by a single manufacturer unless approved by the Engineer.

1.06 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manhole grade rings, cones, and risers: One of the following, or equal.
   1. Old Castle
   2. Approved equal.

B. Manhole frames and covers: Manufacturers: One of the following, or equal.
   1. EJ
   2. Neenah Foundry Company.
   3. Deeter Foundry

2.02 BASIS OF DESIGN

A. Design in accordance with local jurisdiction requirements, Standard Specifications including, but not limited to, the following:
   1. Manhole frames and covers.
   2. Manhole diameter tolerance.
   3. Manhole length.
   4. Manhole cover bolting.
   5. Manhole backfill.

B. Structural design calculations:
   1. Load rating of manhole:
      a. Design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading**.**
   2. Resist buoyancy:
      a. Design with sufficient bottom anchorage and side friction to resist buoyancy.
      b. Depths will be as indicated on the Drawings**.**
      c. Refer to the geotechnical report for soil condition, including fully saturated soil conditions.

C. Manholes, grade rings, risers, and bases:
   1. Manhole:
      a. Nominal sizes as indicated on the Drawings.
   2. Grade rings:
      a. At least 1 but not more than 2 grade rings shall be used.
      b. Maximum total distance from top of cone section to final grade: 18 inches.
   3. Cone and riser sections:
      a. As specified in this Section and as indicated on the Drawings.
      b. Cone sections shall be eccentric.
   4. Manhole bases:
      a. As specified in this Section and as indicated on the Drawings.
      b. Provide corrosion protection system on unlined concrete.

D. Threaded lifting inserts:
   1. Design inserts to be fully threaded:
      a. Do not fully penetrate through entire manhole wall.
   2. Provide lifting device compatible with spreader bar and chains, hooks and slings.
   3. Design with minimum safety factor of 4.0.
   4. Do not use reinforcing steel bars.

2.03 MATERIALS

A. Cast iron manhole frames and covers.
   1. In accordance with ASTM A48.
   2. Concrete collars: As indicated on the Drawings.

B. Manhole bases, risers, and grade rings:
   1. Cement: Type II Portland cement in accordance with ASTM C150.
   2. Concrete aggregates: In accordance with ASTM C33, gradation as specified in approved mix design.
   3. Sections: Steel reinforced.
   4. Precast concrete sections: Manufactured by a process that will produce a dense, homogeneous concrete ring.
   5. Top and bottom of sections: Parallel.

C. Joint sealant:
   1. Preformed, cold applied flexible joint sealant in accordance with ASTM C990 and ASTM C443.
   2. Manufacturers: One of the following, or equal.
      a. Henry Corp., Ram-Nek.
      b. Kent Seal - Hamilton Kent Corp.

2.04 COMPONENTS

A. Pipe stubs:
   1. Provide pipe stubs at manhole locations and in accordance with details indicated on the Drawings and as specified.
   2. Plugging stubs:
      a. Plug stubs with vitrified clay stopper, brick plug, or other materials as indicated on the Drawings.

b. Unless otherwise indicated on the Drawings, comply with following:
    1) Stubs up to and including 21 inches: Vitrified clay stoppers.
    2) Stubs greater than 21 inches: Brick plugs.

B. Resilient pipe connectors:
1. Unless otherwise indicated on the Drawings or specified, provide a flexible compression type connector between manhole and pipes entering and leaving the manhole in accordance with ASTM C923.
2. Resilient pipe connectors:
    a. Manufacturers: The following or equal.
        1) A-LOK Premium.

C. Threaded lifting inserts.

D. Drop manholes:
1. Construct drop manholes at locations and in accordance with details indicated on the Drawings.
2. Provide inside diameter of drop inlet pipe the same as intercepted sewer unless otherwise indicated on the Drawings or specified in this Section.
3. Furnish and set fittings as indicated on the Drawings.

2.05 IDENTIFICATION MARKINGS

A. Identification marks on the exterior of bases, risers, grade rings, and include the following information:
1. Date of manufacture of the item.
2. Name or trademark of the manufacturer.
3. Internal diameter in inches.
4. Number of the manhole as indicated on the Drawings.

2.06 QUALITY CONTROL

A. Manufacturer to provide permanent quality control department and laboratory facility capable of performing inspections and testing as specified by this Section.

B. Material testing, inspection procedures, and manufacturing process are subject to inspection by the Owner or Owner’s representative.

C. Perform manufacturer’s tests and inspections in accordance with the referenced standards and as specified in this Section including the following:
1. Provide the Manufacturer’s Certificate of Source Testing as specified in Section 01600 - Product Requirements.
2. Manufacturer shall make available services of representative throughout the project duration when deemed necessary by the Engineer.
3. Calibrate within last 12 months for equipment such as scales, measuring devices and calibration tools used in the manufacturing of pipe.
    a. Each device used in the manufacture of manholes is required to have a tag recording date of last calibration.
    b. Devices are subject to inspection by the Engineer.

D. Furnish labor necessary to assist the Engineer in inspecting manholes upon delivery.

E. Remove rejected manholes immediately.

PART 3 EXECUTION

3.01 MANHOLE INSTALLATION

A. Excavate and backfill as specified in Section 02318 - Trenching and as indicated on the Drawings.

B. Maintain identification markings on installed pieces throughout installation.

C. Do not use sections with chips or cracks in the joint.

D. Engineer may inspect manhole sections, prior to installation.

E. Repair of manhole sections damaged during installation in accordance with manufacturer's repair procedures; with the concurrence of the Engineer.

F. Install joint sealant material in accordance with manufacturer's instructions:
   1. Completed manhole: Rigid and watertight.

G. Fill threaded lifting inserts with grout.

H. Lay grade rings on joint sealant with sides plumb and tops level.

I. Set frame and covers as specified and as indicated on the Drawings.

J. Apply dampproofing as specified in Section 07110 - Dampproofing, and as indicated on the Drawings.
   1. Apply material in accordance with manufacturer recommendations over the entire exterior surface of the completed manhole, including base section, riser sections, cone section, and grade rings prior to backfilling the manhole.
   2. Allow waterproofing material to dry sufficiently before backfilling.

3.02 CLEANING

A. After completing each manhole, remove debris, construction materials, and equipment from the site of the work, grade, and smooth over the surface and leave the entire right-of-way in a clean, neat, and serviceable condition.

B. After completing each manhole, remove construction material debris from inside the manhole.

3.03 FUNCTIONAL TESTING

A. Provide materials for grouting and patching recommended by the manufacturer or an approved equal.

B. Vacuum testing in accordance with ASTM C1244.
   1. Install the vacuum test head on top of the manhole.
      a. Install and brace sealing devices on influent and effluent pipes.

2. Draw a vacuum of 10 inches of mercury with a vacuum pump, deactivate the pump, and measure the actual elapsed time for the vacuum to drop to 9 inches of mercury.
3. Compare test results with the minimum time requirements stated in the table below.
    a. If the actual elapsed time is less than the time in the table, the manhole is defective, and it shall be repaired and retested until it is acceptable.

Minimum Elapsed Time, Minutes: Seconds				
Manhole Depth, ft.	**Manhole Diameter, inches**			
	36	**48**	**60**	**72**
8	0:14	0:20	0:26	0:33
10	0:18	0:25	0:33	0:41
12	0:21	0:30	0:39	0:49
14	0:25	0:35	0:46	0:57
16	0:28	0:40	0:52	1:07
18	0:32	0:45	0:59	1:13
20	0:35	0:50	1:05	1:21
22	0:38	0:55	1:12	1:29
24	0:42	0:59	1:18	1:37
26	0:46	1:04	1:25	1:45
28	0:49	1:09	1:31	1:53
30	0:53	1:14	1:38	2:01

END OF SECTION

SECTION 02620

FILTER FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Nonwoven filter fabric.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   7. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Filter Fabric: Nonwoven geotextile fabric manufactured from polypropylene fibers.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish filter fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Take field measurements to determine the lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex 401.
   2. Ten Cate Geosynthetics, Mirafi 140N.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property (1)	Test Method	Unit	Requirements (1)
Minimum Weight	ASTM D5261	oz	4.0
Grab Tensile Strength	ASTM D4632	lbs	100
Grab Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs	50
CBR Puncture Resistance	ASTM D6241	lbs	300
UV Resistance (strength retained at 500 hours)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	70
Permittivity	ASTM D4491	sec^{-1}	1.7
Flow Rate	ASTM D4491	gpm/ft^2	130
(1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of filter fabric.

3.02 PREPARATION

A. Surface preparation:
   1. During grading operations, take care not to disturb the subgrade.
   2. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the filter fabric smoothly without folds or wrinkles.

C. Use special care when placing the filter in contact with the soil so that no void spaces occur between the filter and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than manufacturer's instructions.

E. Do not drag filter fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers if necessary. Do not allow equipment directly on filter fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection:
   1. Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric.
   2. Repair all holes and rips by placing a new layer of fabric extending beyond the defect in all directions a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02621

STABILIZATION FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Woven stabilization fabric used for subgrade enhancement.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Stabilization Fabric: Woven geotextile fabric manufactured from polypropylene yarns.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Installation Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish stabilization fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Field measurements:
   1. Take field measurements to determine the exact lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex, 315ST.
   2. Ten Cate Geosynthetics, Mirafi 600X.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property (1)	Test Method	Unit	Requirements (1)
Grab Tensile Strength	ASTM D4632	lbs	315
Grab Elongation	ASTM D4632	%	15
Trapezoid Tear Strength	ASTM D4533	lbs	120
CBR Puncture Resistance	ASTM D6241	lbs	900
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	40
Permittivity	ASTM D4491	sec^{-1}	0.05
Flow Rate	ASTM D4491	gpm/ft^2	4
(1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of stabilization fabric.

3.02 PREPARATION

A. Surface preparation: During grading operations, take care not to disturb the subgrade. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the stabilization fabric smoothly without folds or wrinkles.

C. Use special care when placing the stabilization fabric in contact with the soil so that no void spaces occur between the stabilization fabric and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than recommended by manufacturer.

E. Do not drag stabilization fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers, if necessary. Do not allow equipment directly on stabilization fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection: Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric. Repair all holes or rips by placing a new layer of fabric extending beyond the defect in all directions, a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02742

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Asphalt concrete pavement on prepared subgrade or aggregate base course, and on existing pavement, to lines, grades, compacted thicknesses, and cross sections indicated on the Drawings.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Transportation Materials and Methods of Sampling and Testing:
      a. MP1: Specification for Performance Graded Asphalt Binder.

B. American Public Works Association (APWA), Utah Chapter
   1. 2017 Manual of Standard Specifications (Standard Specifications).

C. ASTM International (ASTM):
   1. C117 - Standard Test Method for Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D977 - Standard Specification for Emulsified Asphalt.
   5. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
   6. D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   7. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   8. D6373 - Standard Specification for Performance-Graded Asphalt Binder

D. Utah Department of Transportation (UDOT):
   1. Standard Specifications for Road and Bridge Construction

1.03 DEFINITIONS

A. Bituminous Prime Coat: Consist of application of hot bituminous material on previously prepared base course.

B. RAP - Recycled Asphalt Pavement: Crushed or milled asphalt materials that have been removed from pavements.

1.04 SUBMITTALS

A. Proposed mix design and gradation of materials.

B. Proposed laydown plan with joint locations identified.

C. Quality control Submittals:
   1. Certificate of Compliance.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Hot Mix Asphalt delivery:
   1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of foreign materials.
   2. Treat bodies as necessary to prevent material from sticking to the bodies.
   3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

B. Comply with Standard Specifications delivery, storage, and handling requirements, if applicable.

1.06 PROJECT CONDITIONS

A. Environmental requirements:
   1. Asphalt concrete:
      a. Place only when surface is dry, and when atmospheric temperature in the shade is 40 degrees Fahrenheit and rising, or above 50 degrees Fahrenheit if falling.
      b. Do not place when weather is foggy or rainy or when base on which material is to be placed is in wet or frozen condition.
   2. Prime coat:
      a. Do not apply when atmospheric temperature is below 60 degrees Fahrenheit.
      b. Apply only when base course is dry or contains moisture not in excess of that which will permit uniform distribution and desired penetration.

1.07 SEQUENCING AND SCHEDULING

A. Pre-paving meeting at least 2 weeks prior to paving.

B. Prime coat:
   1. Prior to requesting Engineer’s acceptance for application, inspect area to be coated to determine its fitness to receive bituminous priming material.
   2. Do not begin application before area to be coated has been accepted for application by the Engineer.

C. Tack coat:
   1. Prior to requesting Engineer's acceptance for application, inspect area to be coated to determine its fitness to receive tack coat material.
   2. All vertical surfaces of concrete and asphalt to receive adjacent asphalt paving are to be coated with tack coat.

3. Do not begin application before area to be coated has been accepted for application by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. See the sections below regarding requirements for densities, thickness, etc. of Asphalt Concrete and associated materials.

2.02 MATERIALS

A. Base material: Aggregate base course material as specified in Section 02050 - Soils and Aggregates for Earthwork.
   1. Thickness: As indicated on the Drawings.
      a. Maximum lift thickness: 4 inches.
   2. Compaction: Minimum 95 percent of the AASHTO T-180 maximum dry density.

B. Prime coat:
   1. Use bituminous material in accordance with Standard Specifications.
   2. Apply at rate of 0.1 to 0.5 gallons per square yard by use of bituminous distributor.

C. Sand: Clean natural aggregate passing the No. 4 sieve and retained on the No. 200 sieve.

D. Tack coat: Use bituminous material in accordance with Standard Specifications.

E. Asphalt concrete materials:
   1. Asphalt Binder: Conform to requirements for asphalt binder, PG 58-28 AASHTO MP1.
   2. Thickness: Minimum of 4 inches or as indicated on the drawings.
   3. Road Class II
   4. Density and Thickness Requirements:
      a. Density Requirements:
         1) The target for in-place density for the mat is 93.5 percent of Theoretical Maximum Specific Gravity (Gmm) except or thin overly pavements.
         2) The target for in-place density for the longitudinal joint is 91.5 percent of the Theoretical Maximum Specific Gravity (Gmm)
         3) Densities will be verified by nuclear methods per ASTM D2950.
         4) Cores for verification of asphalt density and thickness may be requested by Owner or Engineer. Using the cores for densities, use the average of the Theoretical Maximum Specific Gravity for cores taken. Fill core holes with HMA.
         5) Acceptance for in-place mat and longitudinal joint density may be based on establishing a rolling pattern.

b. Thickness Requirements:
   1) Thickness is to be a minimum of 4” or as indicated on the drawings.
   2) Thickness to be verified by Ground Penetrating Radar (GPR) per ASTM D4748 witnessed by the Engineer. Reports to be submitted to Engineer.
   3) At Owner or Engineer request, cores to be taken to verify thickness. Thickness requirements will only be based on mat cores. The thickness requirements may be waved when matching up to existing pavement and curb and gutter.

5. Mix Design Parameters:

Mix Design Parameters		
	SuperPave	
Compaction Level	Road Class I/II	50Nd
	Road Class III	75Nd
Design Air Void Target, percent (b)	3.5	
Void in Mineral Aggregate (VMA) relative to nominal sieve size grading and calculated using Gsb (dry), percent, minimum	ASTM D3202	
	Nominal Grading	
Road Class II/III	1/2	14.2
Road Class I	3/8	15.2
RAP specific gravity for calculations	Gsb (dry) for chemical extraction	
Dust to Binder Ration, maximum	1.6	
Tensile Strength Ration (moisture sensitivity), minimum (c,e)	AASHTO T283	
Road Class I	80%	
Rutting (Hamburg Rut Test) (a,d,e)	AASHTO T283	
Road Class II	15 mm/ 10,000 passes	
Road Class III	10 mm/ 20,000 passes	

Notes:

(a) Road Class as specified in this section.

(b) Design Density Target: See ASTM D2041 T209. Percent of maximum theoretical specific gravity.

(c) Tensile Strength Ratio (moisture sensitivity): Use one cycle of freeze-thaw conditioning. Compact test specimen to 7 percent plus or minus 1 percent air voids.

(d) With testing performed at temperatures representing the specified binder grade in the Hamburg rut test, the average rut depth of 2 mix design test samples is less than the amount of shown for the respective Road Classes.

6. Mineral aggregate:
   a. Consist of coarse aggregate of crushed stone or gravel composed of hard, durable particles, sand, and filler as follows:
      1) Coarse aggregate: Portion of material retained on Number 8 sieve. Fine aggregate: That portion passing Number 8 sieve.
   b. Provide composite material that is uniformly graded from coarse to fine and that complies with requirements of one of following gradings when tested in accordance with ASTM C136.
   c. Asphalt Mix: Mix Gradations to be SP-1/2 for Road Class II per the table below:

Hot Mix Asphalt Gradations		
Sieve Size	**SP-1/2**	**SP-3/8**
1 inch	-	-
3/4 inch	100.0	-
1/2 inch	90.0 – 100.0	100.0
3/8 inch	< 90.0	90.0 – 100.0
No. 4	-	< 90.0
No. 8	28.0 – 50.0	32.0 – 67.0
No. 200	2.0 – 10.0	2.0 – 10.0

7. Coarse aggregate:
   a. Consist of at least 70 percent by weight of each size aggregate and consist of particles that have at least 1 rough, angular surface produced by crushing:
      1) Have percentage of wear of not more than 50 at 500 revolutions, in accordance with ASTM C131.
   b. Aggregate plasticity index: Not more than 2 in accordance with ASTM D4318.
   c. Sand may be added to crusher or pit-run product to supply any deficiency in Number 8 sieve and filler may be added to supply any deficiency in Number 200 sieve material. If aggregate contains an excess of sand, wasting will be required.
   d. Filler:
      1) Use finely powdered limestone, portland cement, or other artificially or naturally powdered mineral dust acceptable to the Engineer.
      2) Weigh filler and add separately to each batch at time of proportioning.
      3) Use filler that is free from deleterious matter of any kind.
      4) Fineness that meet the following requirements:
         a) Passing Number 50 sieve: 100 percent.
         b) Passing Number 200 sieve: At least 75 percent.
      5) Determine amount of material passing the Number 200 sieve in accordance with ASTM C117.
   e. Provide composite aggregate that is free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter which would prevent thorough coating of asphalt binder.

8. Reclaimed Asphalt Pavement (RAP):
    a. Do not adjust the asphalt binder grade if the lower end is already a PG XX-34.
    b. Do not adjust the asphalt binder grade when RAP content is not more than 15 percent by total weight of the hot mix and RAP asphalt binder content is not more than 15 percent of the total asphalt binder content by weight.
    c. Adjust asphalt binder grade according to AASHTO M 323 when RAP asphalt binder content is between 15 to 25 percent of the asphalt binder weight.
        1) Select one grade softer than the grade specified. Do not adjust the asphalt binder grade if the lower end is already a PG XX-34.
        2) Provide test reports indicating that the PG grade and quantity of the recovered asphalt binder is consistent throughout the stockpile.
        3) Limit RAP to 25 percent of the total weight of the hot mix and RAP binder to 25 percent of the total binder.

2.03 EQUIPMENT

A. Bituminous distributor: Designed and equipped so as to distribute bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rate with pressure range of 25 to 75 pounds per square inch.

B. Liquid asphalt distributor:
    1. Designed and operated to distribute asphaltic material in uniform spray without atomization.
    2. Equipped with bitumeter having dial registering feet of travel per minute.
        a. Locate dial so that it is visible to truck driver so that he can maintain constant speed required for application at specified rate.
    3. Equip pump with tachometer having dial registering gallons per minute passing through nozzles.
        a. Locate dial so that it is readily visible to operator.
    4. Provide means for accurately indicating temperature of asphaltic material in distributor at all times.
        a. Locate thermometer well so that it is not in contact with, or close to, heating tube.
    5. Have spray bar having normal width of application of not less than 12 feet and capable of providing for application of lesser width when necessary.
    6. Provided with hose and spray nozzle attachment for applying asphaltic material to patches and areas inaccessible to spray bar.
    7. Equipped with heating attachments and capable of circulating asphaltic material through spray bar during entire heating process.

C. Asphalt concrete mixing plants:
    1. Equipment:
        a. Use screen and storage bins at plant of sufficient capacity to furnish the necessary amount of aggregates, when operating at the maximum capacity of the plant, with no periods of undue waiting for material.
            1) Use bins consisting of at least 2 compartments, so proportioned as to ensure adequate storage of appropriate fractions of the aggregate.

2) Provide each compartment with an overflow pipe of such size and at such location as to prevent any backing up of material into other compartments.

b. Dryer:
   1) Designed to heat and dry the aggregate to Specification requirements and to agitate it continuously during the heating.
   2) Capable of preparing aggregates at a rate equal to the full-rated capacity of the plant.

c. Dust collector:
   1) So constructed as to waste or return uniformly to the hot elevator all or any part of the material collected.

d. Mixer:
   1) Adequate capacity, with twin shafts.

e. Thermometers:
   1) Furnished for determining the temperature of the mix.

f. Weighing and measuring equipment:
   1) Weighing or volumetric measuring equipment of sufficient capacity.
   2) Devices to permit easy readjustment of any working part needing readjustment, so that the equipment will function properly and accurately.
   3) Attach scales for weighing to the bucket.
   4) Test and seal weighing equipment by a representative of the Inspector of Weights and Measures having jurisdiction, as often as the Engineer may deem necessary to ensure accuracy.

g. Tanks for storage of bituminous material:
   1) Capable of heating the material under effective and positive control at all times to temperatures within the range stipulated.

2. Asphalt concrete plant operation:

a. Mineral aggregate:
   1) Dry and heat mineral and then screen into at least 2 fractions and conveyed into separate compartments ready for proportioning and mixing.
   2) When combined with asphalt cement.

b. Aggregate:
   1) Contain not more than 2 percent moisture by weight.
   2) Be at a temperature within the range of that specified for the asphalt cement but not more than 25 degrees Fahrenheit above the temperature of the asphalt cement.

c. Combine dry aggregate in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading.
   1) Introduce the asphalt cement into the mixer in the amount and at the temperature for the particular material being used.
   2) Continue mixing for at least 30 seconds, and for such longer period as may be necessary to coat the particles.

d. When a continuous mixer is used, determine the mixing time by weight method using the following formula:
   1) Mixing time in seconds = Pugmill dead capacity in pounds.
   2) Pugmill output in pounds per second.

D. Asphalt-concrete-placing equipment:
    1. Use equipment for placing, spreading, shaping, and finishing asphalt concrete consisting of a self-contained power machine operating in such manner that no supplemental spreading, shaping, or finishing is required to provide surface that complies with requirements for smoothness contained in this Section.
        a. In areas inaccessible to the machine, hand spreading may be permitted.
    2. Furnish 1 self-propelled, pneumatic-tired roller, and one 8-ton (minimum), smooth-wheel tandem roller.
        a. When spreading is in excess of 100 tons per hour, furnish 1 additional roller of either type for each additional 100 tons, or fraction thereof, spread per hour.

2.04 MIXES

A. Asphalt binder:
    1. Do not mix at temperatures lower than 275 degrees Fahrenheit or higher than 325 degrees Fahrenheit.
    2. Usual amount of asphalt cement, by weight, to be added to aggregate be 5.4 to 5.8 percent of weight of mixture.

B. Asphalt concrete:
    1. Before being delivered to the site, mix aggregate with asphalt cement at the central mixing plant.
    2. Use mixing plants that are in good working order with no excessively worn parts and so equipped that:
        a. Temperatures of aggregates leaving dryer, of asphalt cement entering mixer, and of mix leaving mixer can be readily determined and positively controlled within Specification limits at all times.
        b. Weights of different sizes of aggregates and of asphalt cement as set by the Engineer can be consistently introduced into the mixer.
        c. Asphalt cement can be uniformly distributed throughout the mixture with aggregate completely coated.
        d. Mixing time can be positively controlled to minimum specified.
        e. Bin samples of aggregate can be readily obtained.
        f. Provide means of calibrating weighing devices.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection:
    1. Prime-coated surfaces:
        a. Maintain surfaces until succeeding layer of pavement has been placed.
        b. During this interval, protect primed surfaces against damage and repair any broken spots.

B. Surface preparation:
   1. Prime coat:
      a. Where portions of base course prepared for immediate treatment are excessively dry, sprinkle such portions lightly with water immediately in advance of prime coat application.
      b. Immediately following preparation of base course, apply bituminous material by means of bituminous distributor at the temperature previously specified.
      c. Apply priming material in manner that results in uniform distribution being obtained at all points of surface to be primed.
      d. Following the application of prime material, allow the surface to dry for a period of not less than 48 hours without being disturbed, or for such additional period of time as may be necessary to obtain penetration into the base course and drying out or evaporation of the volatiles from prime material.
      e. Spread sufficient sand on areas that show an excess of bituminous material to effectively blot up and cure the excess.
   2. Base courses:
      a. Thoroughly clean base and apply prime coat before placing asphalt concrete.
      b. Thoroughly clean any existing base, surfacing, or pavement prior to placing plant-mixed surfacing.
      c. Where existing pavement is being widened or extended, cut to straight vertical face and treat with asphalt paint binder prior to paving operations.
      d. When asphalt concrete is to be applied over existing pavement and local irregularities in existing surface would result in course of more than specified thickness, bring surface of existing pavement to uniform contour by patching with asphalt concrete thoroughly tamped or rolled until it conforms with surrounding surface, and then apply tack coat.

3.02 APPLICATION

A. At existing asphalt to be paved over: Apply tack coat at minimum rate of 0.10 gallons per square yard.

B. Placing and compacting asphalt concrete:
   1. Placing and compacting asphalt mixture: Progress in sections generally not more than 750 linear feet in length.
   2. Spreading of mixture:
      a. Spread, shape, and finish by specified equipment.
      b. Spread each successive strip adjacent to previously spread strip.
      c. Do not compact minimum 6-inch width of each strip adjacent to new strip until after new strip has been placed.
      d. Spread as nearly continuous as possible.
      e. Laying against vertical surfaces such as gutters: Roughen and clean face of vertical surfaces as required for proper bonding and then paint with light coating of asphalt cement or emulsified asphalt.
      f. At terminations of new surface courses: Feather asphalt mixture into existing surface over such distance as may be required to produce smooth riding transition.

g. Base-course and single-course construction: Joined by vertical butt joints, finished and rolled to smooth surface.
h. Rolling:
1) Perform initial or “breakdown” rolling with tandem power roller and follow spreading operation when mixture has reached temperature where it does not “pick up” on rolls.
2) Keep rolls properly moistened but do not use surplus of water.
3) Follow initial rolling with pneumatic roller when mixture is in proper condition and when rolling does not cause undue displacement, cracking, or shoving.
4) Begin rolling at sides and progress gradually to center, lapping each preceding track until entire surface has been rolled.
5) Terminate alternate trips of roller in stops at least three feet distant from any preceding stop.
6) At any place not accessible to roller, thoroughly compact mixture with tampers and finish, if necessary, with hot iron to provide uniform layer over entire width being paved.

3. Provide finish surface having uniform texture.

3.03 FIELD QUALITY CONTROL

A. Base course density tests:
1. Taken at locations suitable to confirm compliance with compaction requirements.
2. Take a minimum of 1 test per 1,000 square yards for each lift.

B. Placement:
1. Place the mixture on the roads, pavements, or walks at a temperature not less than 225 degrees Fahrenheit.

C. Curing time:
1. Allow asphalt concrete to cure for the following time periods:
a. Minimum 24 hours before foot traffic is allowed.
b. Minimum 5 days before vehicle traffic is allowed.
c. Minimum 10 days before overnight parking is allowed.
d. Minimum 20 days before heavy construction vehicle traffic is allowed.
2. Provide barricades and signs as required to enforce curing time.

D. Asphalt tests:
1. Provide sampling and control testing for the asphalt concrete.
a. Location, type, and size of the samples: Suitable to determine conformance with stability, density, thickness, compaction, and other specified requirements.
b. Use an approved power saw or core drill for cutting samples.
c. Furnish tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed.
d. Take a minimum of 1 sample per 200 tons of asphalt concrete placed.

E. Inspection:
   1. Asphalt concrete:
      a. Test with a 10-foot straightedge laid on the surface parallel with the centerline of the road. Variation of the surface from the testing edge of the straightedge not to exceed 1/4 inch.
      b. Test each course with running water applied on the surface of the pavement. Water shall flow in the direction indicated on the Drawings. After stopping the water, the pavement surface shall have no areas with standing water.

END OF SECTION

SECTION 02747

BITUMINOUS PAVEMENT SURFACE SEAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Seal Coat.
   2. Asphaltic Emulsion.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. T 49 - Standard Method of Test for Penetration of Bituminous Materials.
   2. T 59 - Standard Method of Test for Emulsified Asphalts.

B. American Public Works Association (APWA), Utah Chapter
   1. 2017 Manual of Standard Specifications (Standard Specifications).

C. ASTM International (ASTM):
   1. C88 - Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   2. C117 - Standard Test Method for Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   3. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   4. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   5. D36 - Softening Point of Bituminous Paving Mixtures.
   6. D242 - Mineral Filler for Bituminous Paving Mixtures.
   7. D977 - Standard Specification for Emulsified Asphalt.
   8. D1664 - Coating and Stripping of Bitumen-Aggregate Mixtures.
   9. D2170 - Kinematic Viscosity of Asphalts (Bitumens).
   10. D2419 - Sand Equivalent Value of Soils and Fine Aggregate.
   11. D3319 - Accelerated Polishing of Aggregates Using the British Wheel.
   12. D3628 - Selection and Use of Emulsified Asphalts.
   13. D3910 - Design, Testing, and Construction of Slurry Seal.
   14. D5821 - Determining the percentage of Fractured Particles in Coarse Aggregate.
   15. D6937 - Density of Emulsified Asphalt.

D. Utah Department of Transportation (UDOT):
   1. Standard Specifications for Road and Bridge Construction.

1.03 SUBMITTALS

A. Proposed mix design and gradation of materials.

B. Product data.

C. Material sample.

D. Quality control Submittals:
   1. Certificate of Compliance.

1.04 PREPARATION FOR SEAL COAT

A. Prepare the surface to be sealed in accordance with the following:
   1. Cracks: Type A cap fill per AWPA Standard Plan 266.
   2. Existing pavement markings: Grind off.
   3. Cleaning:
      a. Remove loose material that may cause drag marks
      b. Remove mud spots, sand, dust, oil, vegetation, and other objectionable material.

B. Protect structures, curb, gutter, sidewalks, guard rails, guideposts, etc. from physical damage. Mask-off Street Fixtures.

1.05 PROJECT CONDITIONS

A. Environmental requirements:
   1. Do not place when weather is foggy or rainy or in unsuitable windy weather.
   2. Apply only when surface is dry, and when pavement surfaces and atmospheric temperature in the shade is 45 degrees Fahrenheit and rising.
   3. Cease application if pavement surfaces and atmospheric temperatures are below 55 degrees Fahrenheit and falling or if the finished product will freeze before 24 hours.

1.06 SEQUENCING AND SCHEDULING

A. Pre-sealing meeting at least 2 weeks prior to sealing.

B. Do not begin application before the area to be coated has been accepted for application by the Engineer.

PART 2 PRODUCTS

2.01 ASPHALT BINDER

A. Crack Pouring Asphalt: Rubberized asphalt or asphalt rubber hot pour per Standard Specification 32 01 17.

B. Emulsified Asphalt: CQS-1h quick traffic type, ASTM D3628 with a 2-hour return to traffic quickset. Physical Properties shall be per Table 1 in Standard Specification 32 01 13.6.

2.02 AGGREGATE

A. Material: Stone, slag, or other high quality particle or combination clean and free from organic matter or other detrimental substances. Physical Properties shall be per Table 2 in Standard Specification 32 01 13.16.

B. Gradation: Analyzed on a dry weight and percentage passing basis.
   1. Material passing any sieve and retained on the next consecutive sieve is 45 percent maximum.
   2. Target Grading Curve must lie within on one of the following Master Grading Bands. Field Samples shall not vary from the Target Grading Curve by more than the Target Tolerance per Table 3 in Standard Specification 32 01 13.16.

2.03 ADDITIVES

A. Use water that is clean, non-detrimental, and free from salts and contaminant.

B. Mineral Filler: ASTM D242.

C. Portland Cement, hydrated lime, limestone dust, fly ash, or aluminum sulfate to regulate setting time and improve workability.

D. Limestone dust, fly ash, and rock dust to alter aggregate gradation.

2.04 MIX DESIGN

A. Asphalt Binder: Select type and grade of emulsified asphalt, ASTM D3628.

B. Proportioning: Use the consistency test of ASTM D3910 to determine optimum ratio of aggregate, filler, water, and emulsion.

C. Set and Cure Time: Select to meet opening to traffic requirements.

D. Stripping: More than 90 percent of bituminous-coated particles retain asphalt coating, ASTM D1664.

2.05 EQUIPMENT

A. Paver: Use a continuous-flow mixing unit:
   1. Capable of applying at least 15,000 square yards of material per day.
   2. Capable of accurately delivering a predetermined portion of aggregate, water, and asphalt emulsion to the mixing chamber.
   3. Prevent loss of slurry from the distributor by using a mechanical type squeegee distributor equipped with flexible material in contact with the pavement surface.
   4. Has a lateral control device and a flexible strike-off capable of being adjusted to lay the slurry at the mix design application rate.

PART 3 EXECUTION

3.01 APPLICATION

A. General:
   1. Machine meter settings must match mix design. Water and additives may be adjusted (per mix design) for better consistency or set time.
   2. Wait at least 2 hours if an adjacent pass has broken and started to cure.
   3. The seal coat, when cured shall present a uniform, skid-resistant appearance with all cracks filled.
   4. Do not apply lane marking tape or paint for traffic control until layout and placement has been verified with Engineer.

B. In the Spreader Box:
   1. Do not exceed 4 minutes total mixing time.
   2. No additional water.
   3. No lumping, balling or unmixed aggregate.
   4. No segregation of the emulsion and aggregate fines from the coarse aggregate.
   5. No breaking of emulsion.
   6. No overloading. Carry a sufficient amount of slurry in all parts of the spreader box for complete coverage.

C. Spreading:
   1. Dampen surface immediately before application of surface treatment (prevents premature breaking and improves bonding). All surfaces are to be uniformly damp with no free water standing on the surface or in cracks.
   2. Keep material delivery at a constant rate even if forward speed lay-down machine varies.
   3. Do not reduce application rate along edges or around manhole covers.
   4. Apply seal coat right to the edge of the pavement. Do not leave uncovered areas near curbs, street fixtures, or edges.
   5. Make straight lines at all locations.
   6. Place seal coat out to right-of-way line on side streets and intersections.
   7. Use hand squeegees to spread mix in areas that cannot be reached with distribution spray bar.
      a. Provide complete and uniform coverage.
      b. Avoid unsightly appearance from hand work.
   8. If coarse aggregate settles to bottom of mix, remove slurry from pavement.

D. Joints:
   1. Make transverse joints straight-cut butt type, not over-lap type.
   2. Place longitudinal joints on lane lines. Limit overlap to 3 inches maximum.
   3. Tolerance for joint match is 1/4 inch difference in elevation when measured with a 10 feet long straight edge over the joint.
   4. Stop and correct paving operation if longitudinal or transverse joints have uncovered areas or unsightly appearance.

E. Lines
   1. Make straight lines along lip of gutter, shoulders end of streets, and in street intersections. No runoff on these areas will be permitted.

2. Vary edge lines no more than 1 inch per 100 feet.

3.02 TOLERANCES

A. Thickness: Measured in pounds per square yard. Standard application rate applies unless specified elsewhere.

Slurry	Standard	Heavy
SS Type I	8 to 12	10 to 13
SS Type II	12 to 16	15 to 18
SS Type III	15 to 18	22 to 25

3.03 FIELD QUALITY CONTROL

A. Emulsion density testing, ASTM D6937. If testing shows material non-compliance, remove installed product and halt operations until new material is delivered and is known to be in compliance.

B. If an ASTM C136 sieve analysis shows aggregate gradation non-compliance, either remove the material or blend in other aggregates to bring it into compliance. This may require a new mix design. Screening may be required at the stockpile to remove any defective material.

C. Measure the total amounts of material installed, and verify it meets the application rate. Make all emulsion deliveries in the presence of the Engineer.

3.04 AFTER APPLICATION

A. Leave no streaks caused by oversized aggregate particles or buildup on squeegees.

B. Leave no holes, bare spots, or cracks. The seal coat shall be uniform and skid-resistant when cured.

C. Clean Steet Fixtures.

D. Remove spatter, mar and overcoat from curb, gutter, sidewalks guard rails, guideposts, etc.

E. Cure time depends on type of asphalt, mixture characteristics and weather. Keep traffic off of treated surface until seal coat does not track-out.

F. Do not apply permanent pavement markings or stripe materials until after seal coat has been in-place at least 10 days, or as permitted by Engineer.

END OF SECTION

SECTION 02762

PAVEMENT MARKINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pavement marking requirements for striping, text, and graphics; traffic signs.

1.02 SUBMITTALS

A. Product data.

B. Manufacturer's instructions.

1.03 QUALITY ASSURANCE

A. Applicator qualifications: Minimum 5 years of experience of applying traffic markings with satisfactory performance record.

B. Regulatory requirements: Comply with applicable requirements of governmental agencies having jurisdiction, including airborne emissions and industrial waste disposal requirements.

1.04 PROJECT CONDITIONS

A. Apply pavement marking paint when:
   1. Pavement is clean and thoroughly dry.
   2. Ambient temperature is above 40 degrees Fahrenheit.
   3. Precipitation is not expected within 12 hours of completion of application.

PART 2 PRODUCTS

2.01 PAVEMENT MARKING PAINT

A. Manufacturers: One of the following or equal:
   1. Dunn-Edwards Corp.
   2. Glidden Co.
   3. Sherwin Williams Co.

B. Materials:
   1. Pavement marking paint, latex based: One of the following or equal:
      a. Dunn-Edwards: No. W 801, Vin-L-Stripe, epoxy-modified acrylic-latex based paint.
      b. Glidden: 63240 Series, UltraHide Latex Traffic Paint.
      c. Sherwin Williams: Set fast acrylic water borne traffic marking paint.

2. Masonry conditioner: The following or equal:
    a. Sherwin Williams: B46WZ1000, Masonry Conditioner.
3. Colors:
    a. Text: White.
    b. Parking dividers: White.
    c. No parking zone markings: Yellow.
    d. No parking curb: Red.
    e. Handicap zone markings: Blue and white.
        1) Blue paint: Match color No. 15090 in Federal Standard 595A
    f. Accessible parking dividers and accessible route: Yellow.
    g. Directional arrows: White.
    h. Driving lane dividers: White.

2.02 TRAFFIC SIGNS

A. Manufacturers: One of the following or equal:
    1. Seton Name Plate Co.
    2. Emedco.

B. Material, shapes, and graphics: Post mounted baked enamel on steel sheet, reflectorized to show the same shape and color both day and night, with mounting holes, in accordance with the Uniform Traffic Control Devices manual. Fasten sign to post with stainless steel bolts.

PART 3 EXECUTION

3.01 PREPARATION

A. Remove dirt, oil, grease, and other materials which may affect paint adhesion.

B. Apply masonry conditioner on weathered or sandblasted surfaces, brick, or stucco.

3.02 APPLICATION

A. Apply paint at package consistency whenever possible. Thin paint as little as possible.

B. Apply paint with specifically designed and manufactured equipment for pavement marking. Provide:
    1. Uniform straight edges without overspray.
    2. 4 inch wide lines, unless indicated otherwise.
    3. Hatching in handicap parking areas.

C. Provide striping between parking stalls as indicated on the Drawings:
    1. Identify parking spaces with text as indicated on the Drawings:
        a. Compact spaces: COMPACT.
        b. Carpool spaces: CARPOOL.
        c. Motorcycle spaces: MOTORCYCLE.
        d. Visitor spaces: VISITOR.

D. Apply paint to obtain thickness recommended by paint manufacturer.

E. Paint traffic control markings, including striping, directional arrows, crosswalks and lettering, and handicap striping and symbols as indicated on the Drawings and in accordance with local governing agency's standards. Use stencils for arrows, lettering, and symbols.

F. Apply 700 square inch international handicap symbol on pavement surface where indicated on the Drawings:
   1. On asphalt surfaces, paint blue symbol on white square.
   2. On concrete surfaces, paint white symbol on blue square.

G. Install traffic signs where indicated on the Drawings. Set post in concrete to depth to resist sign damage from wind speed of 100 miles per hour.

END OF SECTION

SECTION 02772

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Concrete curbs, gutters, sidewalks, driveways, access ramps, and alley intersections.

1.02 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Samples: Submit samples when requested.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements: Construct various types of concrete curb, gutter, sidewalk, driveways and alley intersections to dimensions and details indicated on the Drawings.

2.02 MATERIALS

A. Concrete: Class PM, as specified in Section 03300 - Cast-In-Place Concrete.

B. Curb finishing mortar: 1 part Portland cement to 2 parts sand.

C. Form release material: Light oil or other releasing agent of type which does not discolor concrete or interfere with the application of finishing mortar to curb tops and faces.

D. Joint materials:
   1. Expansion: As specified in Section 03150 - Concrete Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Verify field conditions, including subgrade condition and interferences, before beginning construction.

3.02 PREPARATION

A. Surface preparation:
   1. Subgrade:
      a. Construct and compact true to grades and lines indicated on the Drawings and requirements as specified Section 02050 - Soils and Aggregates for Earthwork.
      b. Remove soft or unsuitable material to depth of not less than 6 inches below subgrade elevation and replace with satisfactory material.
   2. Forms and subgrade: Water immediately in advance of placing concrete.

3.03 INSTALLATION

A. Special techniques:
   1. Contractor's option:
      a. Construct concrete curbs and gutters by conventional use of forms, or by means of curb and gutter machine when acceptable to the Engineer.
      b. When use of machines designed specifically for work of this Section are accepted by the Engineer, results must be equal to or better than those produced by use of forms.
      c. Applicable requirements of construction that apply to use of forms also apply to use of machines.
      d. Discontinue use of machines when results are not satisfactory to the Engineer.

B. Forms:
   1. Carefully set to line and grade and securely stake in position forms conforming to dimensions of items to be constructed.
   2. Thoroughly clean prior to each use and coat with form releasing material.

C. Expansion and weakened-plane joints:
   1. Expansion joints:
      a. Construct vertically, and at right angles to centerline of street and match joints in adjacent pavement or sidewalks.
      b. Constructed at radius points, driveways, alley entrances, and at adjoining structures.
      c. Fill joints with expansion joint filler material.
   2. Weakened-plane joints:
      a. Construct as indicated on the Drawings.
      b. Match joint locations and details in adjacent curbs, gutters, and sidewalks.

D. Concrete:
   1. Placing:
      a. Thoroughly spade concrete away from forms so that no rock pockets exist next to forms and so that no coarse aggregate will show when forms are removed.
   2. Compacting:
      a. Compact by mechanical vibrators accepted by the Engineer.
      b. Continue tamping or vibrating until mortar flushes to surface and coarse aggregate is below concrete surface.

3. Form removal:
    a. Front form faces: Do not remove before concrete has taken initial set and has sufficient strength to carry its own weight.
    b. Gutter and rear forms: Do not remove until concrete has hardened sufficiently to prevent damage to edges. Take special care to prevent damage.
4. Finishing and curing: Comply with requirements as specified in Section 03366 - Concrete Finishes, except as modified here:
    a. As soon as curb face forms are stripped, apply finishing mortar to the top and face of curb and trowel to a smooth, even finish. Finish with fine haired broom in direction of work.
    b. Where curb is installed without integral gutter, extend finish 2 inches below grade.
    c. Edge concrete at expansion joints to 1/4-inch radius.
    d. Flow lines of gutters shall be troweled smooth 4 inches out from curb face for integral curb and gutter and 4 inches on both sides of flowline for gutters without curbs.
    e. Sidewalks and ramps: Broom finish.

E. Backfilling:
1. Unless otherwise specified, backfill behind curbs, gutters, or sidewalks with soil native to area and to lines and grades indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Tests:
1. Curbs and gutters:
    a. Test face, top, back, and flow line with 10-foot straightedge or curve template longitudinally along surface.
    b. Correct deviations in excess of 1/4 inch.
2. Gutters:
    a. Frequency of testing: When required by the Engineer, where gutters have slope of 0.8 foot per 100 feet or less, or where unusual or special conditions cast doubt on capability of gutters to drain.
    b. Test method: Establish flow in length of gutter to be tested by supplying water from hydrant, tank truck, or other source.
    c. Required results:
        1) 1 hour after supply of water is shut off, inspect gutter for evidence of ponding or improper shape.
        2) In event water is found ponded in gutter to depth greater than 1/2 inch, or on adjacent asphalt pavement, correct defect or defects in manner acceptable to the Engineer without additional cost to the Contract.

3.05 ADJUSTING

A. Repair portions of concrete damaged while stripping forms or, when damage is severe, replace such work at no additional cost to the Contract. Evidence of repairs shall not be noticeable in the finished product.

B. Remove and replace sections of work deficient in depth or not conforming to requirements indicated on the Drawings and specified in the Specifications at no additional cost to the Contract. Removal and replacement shall be the complete section between 2 joints.

END OF SECTION

SECTION 02820

FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fence, framework, fabric, and accessories.
   2. Excavation for post bases and concrete foundation for posts.
   3. Manual gates and related hardware.
   4. Gate operators.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   2. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. A385 - Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
   5. A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   6. A702 - Standard Specification for Steel Fence Posts and Assemblies, Hot-Wrought.
   7. F626 - Standard Specification for Fence Fittings.
   8. F668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   9. F1043 - Standard Specification for Strength and Protective Coatings on Steel Industrial Chain Link Fence Framework.
   10. F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.
   11. F2200 - Standard Specification for Automated Vehicular Gate Construction.

B. Underwriters Laboratories, Inc. (UL):
   1. 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.03 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Shop drawings:
   1. Remote and automatic gates: Submit drawings showing connection details indicating methods and means of mounting, attaching, and installing operators and locks to gates, including wiring diagrams.

C. Samples: Provide for polyvinyl chloride coated fabric and accessories.

D. Quality control submittals:
   1. Certificates of compliance: Provide certification that materials conform to referenced specifications.
   2. Qualifications: Provide installer's references and list of local references.
   3. Manufacturer's instructions: Provide for gate operator equipment.

E. Contract closeout submittals:
   1. Operation and maintenance manuals: Provide for electrical and mechanical equipment.

1.04 QUALITY ASSURANCE

A. Pre-installation conference: Participate in conference, if required.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling: Unload, store, and protect materials such that they are not damaged.

1.06 PROJECT CONDITIONS

A. Field measurements:
   1. Verify actual field distances so that post spacing can be made uniform.
   2. Verify and coordinate gate opening and column distances for driveway.

1.07 SEQUENCING AND SCHEDULING

A. Fences and gates: May be constructed at any time after earthwork, pipe work, and structures to which fence is related has been completed, but prior to erosion control application.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chain link fence and gates: One of the following or equal:
   1. Master-Halco.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. 3 strands of barb wire.

B. Performance requirements:
   1. Gate operator controls:
      a. In addition to standard controls furnished with gate operators, make provisions for and provide terminal connection points for controls indicated on the Drawings and clearly indicated such connection points on operator control terminal board.
      b. Operational sequence: Provide sequence as specified in Section 17100 - Control Strategies and 17101 - Specific Control Strategies.

2.03 MATERIALS

A. Chain link fence:
   1. Fabric:
      a. Height:
         1) Plant fence: 6 feet 0 inches.
      b. Mesh: 2 inches.
      c. Size wire: 9 gauge:
         1) Coating: PVC, In accordance with ASTM F668, color selected by Engineer.
         2) Tensile strength: 80,000 pounds per square inch minimum.
   2. Framework: In accordance with ASTM F1043 Group 1A or 1C. Pipe shall be straight and conform to the following weights:

Pipe Size Outside Diameter (Inches)	Group IA Weight (Lbs/ft)	Group IC Weight (Lbs/ft)
1-5/8	2.27	1.84
1-7/8	2.72	2.28
2-3/8	3.65	3.12
2-7/8	5.79	4.64
3-1/2	7.58	5.71
4	9.11	6.56
6-5/8	18.97	-
8-5/8	24.70	-

      a. Top rail:
         1) Size: 1-5/8 inches outside diameter.
      b. Bottom rail:
         1) Tension wire: 7-gauge galvanized coil spring wire.
      c. Line posts:
         1) Size: 1-7/8 inches outside diameter.
      d. Terminal, corner, and pull posts:
         1) Size: 2-7/8 inches outside diameter.
      e. Coatings:
         1) Group IA: PVC external coatings in accordance with ASTM F1043 Type A; internal coatings in accordance with ASTM F1043 Type A.
         2) Group IC: PVC external coatings in accordance with ASTM F1043 Type B; internal coatings in accordance with ASTM F1043 Type D.
   3. Accessories:
      a. Fence fittings: In accordance with ASTM F626:
         1) Post top fittings:
            a) Provide post caps that fit snugly over posts to exclude moisture. Provide dome style caps for terminal posts and loop style caps for line posts.
            b) Extension arms, 45-degree angle type, capable of receiving 3 strands of barbed wire.

2) Rail and brace ends: Provide pressed steel or malleable castings that are cup shaped to receive rail and brace ends.

b. Fabric accessories:
1) Wire clips: Minimum 6 gauge hot-dip galvanized and polyester coated.
2) Tension bars: 1/4 inch by 3/4 inch, galvanized and polyester coated.
3) Steel bands: 11 gauge, 1 inch wide, hot-dip galvanized and polyester coated.
4) Bolts and nuts: 3/8-inch diameter.
5) Hog rings: 11 gauge.

B. Chain link and barbed wire gates:

1. Gate posts and concrete foundations for gate posts: Except where differently indicated on the Drawings, determine gate posts and concrete foundations for gate posts in accordance with following schedule:

Gate Leaf Widths (Feet)	Gate Posts	Foundations	
	Post O.D. ASTM F1043 Group IA or IC (Inches)	Diameter (Inches)	Depth (Feet)
0 to 6	2-7/8	12	4
Over 6 to 13	4	18	4
Over 13 to 18	6-5/8 (Group IA)	18	4
Over 18 to 25	8-5/8 (Group IA)	18	4.5

2. Chain link gates:
a. Frames and center supports: 1-7/8 inch outside diameter galvanized steel pipe that in accordance with ASTM F1043 Group IA or IC.
b. Gate accessories:
1) Post top fittings:
a) Provide post caps that fit snugly over posts to exclude moisture.
b) Provide dome style caps for terminal posts and loop style caps for line posts.
c) Post top fittings: Extension arms, 45 degree angle type, capable of receiving three strands of barbed wire.
2) Corner fittings: Heavy pressed steel or malleable castings.
3) Gate tensioning:
a) Cross tensioning rods: 3/8 inch, galvanized.
b) Turnbuckles: Heavy duty.
4) Tension rods for 4-foot gates: 3/8 inch, easily adjustable, galvanized.
5) Gate frame corner fittings: Fitting designed for purpose, Manufacturer's standard.
6) Horizontal gate stiffeners: 1-5/8-inch outside diameter galvanized steel pipe that in accordance with ASTM F1043 Group IA or IC.
7) Gate hardware:
a) Catch and locking attachment: Combination steel or malleable iron catch and locking attachment of acceptable design.

b) Stops:
(1) Type 1: Capable of holding gates open.
(2) Type 2: Center rest with catch.
c) Color: Match color of fabric.

2.04 MANUFACTURED UNITS

A. Special gates:
1. Vertical Pivot gates:
a. Controls:
1) Provide control for pair of motor operators for each gate by either of 2 manually operated switches located where indicated on the Drawings:
a) Also provide controls for pair of motor operators for each gate controlled by either of 2 key-operated switch stations located at each gate.
b) Provide gooseneck stands for mounting of switch stations.
c) Gate keying: Key gates alike.

2.05 EQUIPMENT

A. Vertical Pivot gates:
1. 1. Reuse existing south gate operators.
2. Motor operators:
a. Motor operator controls: Install mounting stands with key-operated switch stations in following relationship to gates as follows:
1) Locate 1 outside.
2) Locate 1 inside.

B. Outside gate operator stands for plant entry gates:
1. Provide stands containing phone handset connected to in-plant communication system.

2.06 FABRICATION

A. Shop finishing:
1. Galvanizing: For items not fabricated of galvanized materials hot-dip galvanize products after fabrication in accordance with following as applicable:
a. ASTM A123.
b. ASTM A153.
c. ASTM A385.
2. Mark galvanized products with name of galvanize, applicable ASTM designation, and weight of zinc coating.
3. Galvanize fabricated items complete, or in largest practicable sections.
4. Provide galvanizing at rate of 2.0 ounces per square foot, minimum.
5. Hardware:
a. Padlocks: Cadmium plated.
b. Chain: Galvanized.

B. Finish schedule:
   1. Ferrous metal:
      a. Typical: Clean, then hot-dip galvanize in accordance with galvanizing standards.

C. Field finish touch-up painting:
   1. Galvanized repair paint: Apply paint having minimum dry film thickness of 2.0 to 3.5 mils.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify field conditions prior to construction.

3.02 PREPARATION

A. Surface preparation:
   1. Before locating fence posts grade ground to permit grade of fence to remain constant over any local elevations or depressions in ground line.

3.03 INSTALLATION

A. Chain link fences and gates:
   1. General:
      a. Install chain link fence and gates as indicated on the Drawings and specified in this Section.
      b. Provide fence systems that are plumb, taut, true to line and grade, and complete in details.
      c. Install fencing to generally follow finish grade of ground and provide pull posts at points where required to conform to change in grade.
      d. Install fencing such that space between bottom of fence and finish ground line does not exceed 3 inches.
   2. Concrete foundation for fence posts:
      a. Set fence posts in concrete foundations, that extend at least 3 feet into ground, and space posts not over 10 feet apart.
      b. Provide concrete foundations having minimum of 10 inches in diameter for line posts and 12 inches in diameter for corners and gates.
      c. Provide foundations that extend minimum of 1 inch above finish grade and have tops that are shaped to slope to drain away from posts.
      d. Trowel finish tops of footings, and slope or dome to direct water away from posts.
      e. Set keepers, stops, sleeves, tracks, eye bolts, and other accessories into concrete as required.
      f. Wheel rolling area for sliding gates shall be steel-trowel smooth finish concrete.
   3. Post bracing:
      a. End corner, pull, and gate posts: Brace with same material as top rail and trussed to line posts with 3/8-inch rods and tighteners.

b. Bracing end, corner, slope, and gate posts:
    1) Brace to midpoint of nearest line post or posts with horizontal braces used as compression members.
    2) Then from such line posts truss from brace back to bottom of end, corner, slope, or gate post with 3/8-inch steel truss rods with turnbuckles or other suitable tightening devices used as tension members.

4. Top rail:
    a. Unless otherwise specified or indicated on the Drawings, install fencing with top rail and bottom tension wire.
5. Fabric:
    a. Place fabric on outward facing side of the posts and install so that top edge projects over top rail of fence.
    b. Stretch fabric taut and securely fasten to posts, top rail, and bottom tension wire.
    c. Install tension wire parallel to line of fabric.
    d. Fabric: Connect fabric to:
        1) Line posts with wire clips minimum every 14 inches.
        2) Terminal, corner, and gate posts with tension bars tied to posts minimum 14 inches on center and with steel bands and bolts and nuts.
        3) Tension wires with hog rings minimum 24 inches on center.
6. Post top fittings: Provide post tops with extension arms.
7. Swing gates:
    a. Provide chain link fencing with swing gates, unless otherwise indicated on the Drawings or specified in this Section.
    b. Provide swing chain link gates where indicated on the Drawings.

B. **Vertical Pivot** gates:
1. Provide gates that are motor operated:
    a. Motor operator controls:
        1) Install switch station stands where indicated on the Drawings.
    b. Install gates and operators in accordance with UL 325 and ASTM F2200.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's field service:
1. Manufacturer shall check and test powered gates and accessories before acceptance.
2. Test gate operator through 10 full cycles and adjust operation without binding, scraping, or uneven motion.
3. Test limit switches for proper “at rest” gate position.

3.05 ADJUSTING

A. Adjust gate travel, stops, and operator position to meet field conditions.

3.06 CLEANING

A. Clean up surplus dirt, concrete, and other waste material and dress grade up upon completion of the work.

3.07 PROTECTION

A. Protect installed fences and gates against damage and, if damaged, repair prior to final acceptance.

END OF SECTION

SECTION 02939

SEEDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Seeding.

1.02 REFERENCES

A. Association of Official Seed Analysts (AOSA).

B. United States Department of Agriculture (USDA).

C. United States Environment Protection Agency (EPA).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Duff layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
   2. Finish grade: Elevation of finished surface of planting soil.
   3. Manufactured topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
   4. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
   5. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
   6. Planting soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
   7. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
   8. Surface soil: Soil that is present at the top layer of the existing soil profile at the Project Site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

B. Weeds:
   1. Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Russian Thistle, Leafy Spurge, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Weed, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.04 SUBMITTALS

A. Product data: For each type of product indicated:
   1. Pesticides and herbicides: Include product label and manufacturer's application instructions specific to this Project.
   2. Fertilizer and organic matter: Include product label and manufacturer's application instructions specific to this Project.
   3. Soil amendment: Analysis.

B. Certification of grass seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification and inspection as required by governmental authorities of each seed mixture. Include identification of source and name and telephone number of supplier.

C. Qualification data: For qualified landscape installer.

D. Samples: Imported topsoil, organic matter, erosion control blanket and mulch.

E. Product certificates: For soil amendments and fertilizers, from the manufacturer.

F. Maintenance instructions: Recommended procedures to be established by the Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.
   1. Acknowledge and provide list of warranty items in maintenance instructions.

1.05 QUALITY ASSURANCE

A. Installer qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.
   1. Professional membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: 5 years' successful experience in the installation of seeded areas similar in size to this Project.
   3. Installer's field supervision: Require installer to maintain an experienced full-time supervisor on the Project Site when Work is in progress.
   4. Personnel certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
      a. Certified Landscape Technician - Exterior, with installation and irrigation specialty area(s).

5. Maintenance proximity: Not more than 2 hours' normal travel time from the installer's place of business to the Project Site.
6. Pesticide applicator: State-licensed, commercial.

B. Soil-testing laboratory qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil. Refer to plan notes for number and location of soil analysis tests.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. Soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken in accordance with instructions from the Engineer.
    a. A minimum of 3 representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.
    a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated.
        1) State recommendations in weight per 1,000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation conference: Conduct conference at the Project Site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Seed and other packaged materials:
1. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
2. Protect seed during delivery and storage.
3. Seed that has become wet or otherwise damaged will not be acceptable.

B. Deliver packaged materials in waterproof bags showing weight, chemical analysis, and name or trademark of manufacturer.
1. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, percentage of purity (PLS), percentage of germination and location of packaging.

C. Local sourcing of seed not in sealed containers is permitted for smaller projects.

D. Label seed bags per variety.

E. Store materials in protected and covered storage until application or use.

F. Bulk materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

G. Truck receipts: For verification of soil amendments and imported topsoil.

H. Hydroseeding:
   1. Ensure that seed packages are packed to provide adequate protection against injury during transit.
   2. Deliver undamaged sealed seed bags with legible labels showing weight, analysis, vendor's name and address, and point of origin.
      a. Label seed bags per variety.
   3. Deliver dry commercial process or packaging, such as fertilizer, in undisturbed original unopened containers with legible labels showing the manufacturer's guaranteed analysis or description.
   4. Inspect materials and packages upon delivery.
      a. Discard damaged packages or containers immediately.
   5. Store materials in protected and covered storage until application or use.

1.07 WARRANTY

A. Guarantee seeding to be alive and healthy for 1 year following date of final completion by the Engineer.

B. Seeded areas shall have an even stand of grass with germination over 100 percent of the Site within 45 days of seeding.

C. Seeded grass areas are to be ensured of obtaining a satisfactory stand of growth.

D. Total area occupied by bare spots larger than 0.25 square feet must not exceed 10 percent of the total seeded area.

E. Maximum single bare spot size of irrigated seed 3 inches by 3 inches.

F. Maximum single bare spot size of non-irrigated seed is 1 square foot.

G. Seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.

H. Replace seeding when it is no longer in a satisfactory condition or do not meet the preceding standard as determined by the Engineer or the duration of the guarantee/warranty period.
   1. Make replacements as soon as possible within the recommended seeding schedule.

I. Replacements:
   1. Seed of same mix, quality and species as originally specified, as soon as possible within the recommended seeding schedule, with a new 1-year warranty commencing on date of replacement.
   2. Repairs and replacements shall be made at no expense to the Owner.

PART 2 PRODUCTS

2.01 STAKES

A. Softwood lumber, chisel pointed.

2.02 SOIL AMENDMENTS AND FERTILIZERS

A. Apply as indicated on the Drawings.

B. Submit recommendations, along with supporting soil test analysis, for Engineer approval prior to application on the Site.

C. Fertilizer:
   1. Uniform in composition, free flowing and suitable for application with approved equipment, of the proportions necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
   2. Delivered to the Site fully labeled according to applicable laws.
   3. Packaging: Display the name, tradename, trademark, and warranty of the provider.

D. Fertilizer grade description format:
   1. Three sets of 2-digit numbers.
      a. Example: 10-10-10.
   2. Numbers represent the percent by weight of nutrients.
   3. First number is the amount of nitrogen (N).
   4. Second number is the amount of phosphate (P_2O_5).
   5. Third number is the amount of potash (K_2O).

2.03 HERBICIDE AND PESTICIDE

A. Submit labels for Engineer approval.

B. Pesticides:
   1. Registered and approved by the EPA.
   2. Acceptable to authorities having jurisdiction.
   3. Type recommended by the manufacturer for each specific problem.
   4. As required for Project conditions and application.

5. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

C. Pre-emergent herbicide (selective and non-selective):
   1. Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

D. Post-emergent herbicide (selective and non-selective):
   1. Effective for controlling weed growth that has already germinated.

2.04 WATER

A. Use potable water for making up seed mixture.

2.05 SOILS

A. Topsoil:
   1. Fertile soil, typical for locality, capable of sustaining vigorous plant growth.
   2. Taken from drained site.
   3. Free of subsoil, stones more than 1 inch in diameter, clay clumps, or impurities, plants weeds and roots.
   4. Organic content:
      a. Minimum 2 percent by mass.
   5. pH value:
      a. Minimum: 5.5.
      b. Maximum: 7.5.

2.06 SEED

A. Provide seed as indicated on the Drawings.

B. Packaging: Provide separate bags or containers for each variety of seed.

C. Plant seed that is appropriate for planting season.

D. Provide seed from tested lots and delivered to the Project Site in standard containers labeled as required by USDA regulations and applicable state regulations.

E. Use labels that show variety of strain of seed, degree of purity (percent), rate of germination (percent), weed content (percent), and date of test.

F. Grass seed:
   1. Fresh, clean, dry, new crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
   2. Species: Selected by the Owner.
   3. Seed mixture:
      a. Germination minimum: 95 percent.
      b. Pure seed minimum: 85 percent.
      c. Weed seed maximum: 0.5 percent.

d. Other than grass seed, non-viable seed, chaff, hulls, live seed of crop plants (other than those specified), harmless inert matter, and maximum: 18 percent.

2.07 MULCH

A. As indicated on the Drawings.

B. Straw mulch:
   1. Oats, barley, wheat, or rye only.
   2. Free from weeds, foreign matter detrimental to plant life, and dry.
   3. Minimum length 10-inches long: 50 percent of straw.
   4. Not acceptable:
      a. Hay or chopped cornstalks.
      b. Old straw mulch that breaks during crimping.
      c. Straw in such an advanced stage of decomposition as to smother or retard the normal growth of grass.

C. Wood cellulose fiber mulch:
   1. Wood fibers must be capable of being evenly dispersed and suspended when agitated in water.
   2. Furnish with a biodegradable green dye to allow visual metering of its application.
   3. Not acceptable:
      a. Substance or factor which might inhibit germination or growth of grass seed with organic tackifier.

2.08 HYDRO-MULCH

A. Hydro-mulch seed:
   1. Mixture:
      a. Ratio of wood cellulose fiber, seeds, and fertilizer: 4:1:6 mixture.
         1) Fiber: 20 pounds.
         2) Seeds: 5 pounds.
            a) Modify mixture according to the planting season as follows:
               (1) February through August: 20 pounds of hulled common Bermuda grass per acre.
               (2) August through February: Combination of 15 pounds of unhulled common Bermuda and 15 pounds of unhulled Gulf Coast Annual Rye seed per acre.
         3) Fertilizer: 30 pounds.
      b. Coverage: 1,000 square feet.
   2. Provide a recommendation for proposed mixture based on time of year hydro-mulch is actually performed.

B. Hydro-mulching equipment:
   1. Manufacturers: One of the following or equal:
      a. Bowie Industries, Inc.
      b. Finn Equipment Co.
      c. Reinco.

2. Equipment requirements:
    a. Built-in agitation system sufficient to agitate, suspend, and homogeneously mix slurry containing fiber, fertilizers, chemicals, and seed mix.
    b. Capable of slurry distribution line large enough to prevent stoppage.
    c. Equipped with set of hydraulic spray nozzles which provide continuous non-fluctuating discharge of minimum 225 pounds per square inch at end of spray nozzle.

2.09 HYDROSEEDING MATERIALS

A. Seed mix:
    1. Manufacturers: One of the following or equal:
        a. Conwed Corp.
        b. Eva Cell Co.
        c. Grass Growers.
    2. Seed mix from the latest crop.
    3. Minimum pure live seed content to be 80 percent, and tested within the preceding 6 months.
    4. Do not use seed mix after expiration date:
        a. Annual Rye: 25 pounds per acre.
        b. Blando Brome: 20 pounds per acre.
        c. Rose Clover: 20 pounds per acre.
        d. Zorro Annual Fescue: 10 pounds per acre.

B. Mulch:
    1. Wood fiber manufactured for hydroseeding: Fiber mulch.
    2. Manufacturers: One of the following or equal:
        a. Conwed Corp., Fibers Div.
        b. Eva Cell Co.
        c. Grass Growers.

C. Water:
    1. Use potable water for making up seed mixture.

D. Granular fertilizers:
    1. Manufacturers: One of the following or equal:
        a. Green Light Co., Wonder Grow Chemicals.
        b. Kay-Fries Chemicals.
        c. Sierra Chemical Co.
    2. Fertilizer grade: 16-20-0.

2.10 EROSION CONTROL BLANKETS

A. As indicated on the Drawings.

B. Biodegradable wood excelsior, straw, or conduit fiber enclosed in a photodegradable plastic mesh.

C. Provide 6-inch long steel wire staples.

D. Vegetative sod shall be of buffalo grass cultivar selections, Prairie and/or 609 harvested at a depth of at least 2 inches.

E. Manufacturer: The following or equal:
   1. American Excelsior Company, Curlex®.

F. Jute matting, open weave.

G. Regular blanket, machine produced mat of curled wood excelsior of 80 percent, 6 inch or longer fiber length with a consistent width of fibers evenly distributed throughout mat.

H. Photo-biodegradable extruded plastic netting cover the top side of blanket.

I. Secure netting to wood excelsior by extra heavy lines of plastic woven into the width of each blanket.

J. Smolder resistant with no chemical additives.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
   3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Start of Work covered in this Section constitutes the Contractor's approval of existing Site conditions.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by the Engineer and replace with new planting soil.

3.02 SITE CONDITIONS

A. Planting restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date.
   1. Irrigated seed areas: Seed from ground thaw to July 31, and September 1 to October 15.
   2. Non-irrigated seed areas: Seed from March 15 to July 4, and September 1 to October 15.
   3. Pure warm season grass seed areas: Seed from June 1 to August 15.
   4. Dormant seeding areas: Seed from October 15 to ground freeze.
   5. Per seed detail.

B. Coordinate with the Contractor's work requiring access to Site over existing vegetation areas.
   1. No trucking or moving of equipment or materials shall be permitted over completed seed areas.

C. Coordinate with installation of underground system piping and outlets.

D. Weather limitations:
   1. Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.
   2. Apply products during favorable weather conditions according to the manufacturer's written instructions.

3.03 EXISTING VEGETATION RENOVATION

A. Renovate existing vegetation damaged by the Contractor's operations.
   1. Reestablish vegetation where settlement or washouts occur or where minor regrading is required.
   2. Install topsoil as required.

B. Remove sod and vegetation from diseased or unsatisfactory vegetation areas; do not bury in soil.

C. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from the Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing vegetation.

E. Prior to seeding, irrigate for a minimum of 2 weeks to allow germination of weed seeds.
   1. Apply Round-Up herbicide in accordance with the manufacturer's specifications after germination of weed seeds and at least 2 weeks prior to seeding.
   2. Do not spray on a day when wind is detectable.
   3. Remove remaining vegetative matter.
   4. Repeat irrigation and herbicide application until no weeds are evident for 14 days after last herbicide application, as determined by the Engineer.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off the Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

H. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil.
   1. Install new planting soil to fill low spots and meet finish grades.

I. Apply seed and protect with hydro mulch as required for new vegetation.

J. Water newly planted areas and keep moist until new turf is established.

3.04 PREPARATION

A. Protect existing and new structures, fences, utilities, sidewalks, paving, curbs, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydro-mulching overspray.
   2. Protect grade stakes set by others until directed to remove them.
   3. Protect landscaping and other features remaining as final work.

B. Limit turf subgrade preparation to areas to be planted.

C. Newly graded subgrades:
   1. Loosen/scarify subgrade to a minimum depth of 6 inches.
   2. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter, and legally dispose of them off the Owner's property.
   3. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted the subgrade.
   4. Tolerances: Top of subgrade, within 1 inch.

D. Prepare subgrade and eliminate uneven areas and low spots.
   1. Maintain lines, levels, profiles and contours.
   2. Make changes in grade gradual. Blend slopes into level areas.

E. Do not prepare subgrade in areas of on-site plant preservation.

F. Do not bury foreign material beneath areas to be seeded.

G. Remove any contaminated subgrade.
   1. Apply superphosphate fertilizer directly to subgrade before loosening.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      b. Mix lime with dry soil before mixing fertilizer.

2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
    a. Spread approximately half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
    b. Reduce elevation of planting soil to allow for soil thickness of sod.

H. Unchanged subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turf.
    a. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 6 inches.
    a. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil.
    b. Apply superphosphate fertilizer directly to surface soil before loosening.
3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including contaminated soils, grass, vegetation, and turf, off the Owner's property.

I. Finish grading:
1. Grade seeding areas to a smooth, uniform surface plane with loose, uniformly fine texture.
2. Grade to within 1/2 inch of finish elevation.
3. Roll and rake, remove ridges, fill depressions to meet finish grades, and ensure positive surface drainage.
4. Maintain profiles and contour of subgrade.
5. Limit finish grading to areas that can be planted in the immediate future.

J. Rip topsoil that has been spread to a minimum depth of 8 inches in one direction using an agricultural ripper with tines spaced at no greater than 18 inches.
1. Areas adjacent to walks, structures, curbs, etc., where the use of large mechanical equipment is difficult, shall be worked with smaller equipment or by hand.

K. Manually spread topsoil close to plant materials and structures to prevent damage.

L. Spread amendments, as determined by the soil test results or indicated on the Drawings, over the entire area to be seeded and incorporate into the top 6 inches of soil by disking or rototilling until a uniform mixture is obtained with no pockets of soil or amendments remaining.

M. Restore fine grade with float drag to remove irregularities resulting from tilling operations.
1. Float drag or rake in 2 directions.
2. Remove any additional stones over 1 inch that have come to the surface.
3. Perform drainage test by applying water with the irrigation system.
4. Do not plant until the finished grade is reviewed by the Engineer.

5. This review does not reduce the Contractor's responsibility to provide a finished product that drains.

N. Apply fertilizer, if necessary, after smooth raking of topsoil and prior to planting of seed.
   1. Apply fertilizer at a rate as determined by the soil tests or indicated on the Drawings.
   2. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
   3. Mix thoroughly into upper 6 to 8 inches of soil.

O. Lightly water to aid the dissipation of fertilizer.

P. Remove any additional stones over 1 inch that have come to the surface.

Q. Moisten prepared area before planting if soil is dry.
   1. Water thoroughly and allow surface to dry before planting.
   2. Do not create muddy soil.

R. Before planting, obtain the Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

S. Tolerances: Top of topsoil within 1/2 inch.

3.05 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and the manufacturer's written recommendations.
   1. Coordinate applications with the Owner's operations and others in proximity to the Work.
   2. Notify the Owner before each application is performed.

B. Post-emergent herbicides (selective and non-selective): Apply only as necessary to treat already-germinated weeds and in accordance with the manufacturer's written recommendations.

3.06 SEED

A. Preparation for seeding:
   1. Prior to seeding, if weeds exist, apply Round-Up herbicide in accordance with the manufacturer's specifications after germination of weed seeds and at least 2 weeks prior to seeding.
   2. Do not spray on a day when wind is detectable.
   3. Remove remaining vegetative matter.
   4. Repeat herbicide application until no weeds are evident for 14 days after last herbicide application, as determined by the Engineer.

B. Drill seeding:
   1. Drill seed by means of a Brillion mechanical power-drawn drill seeder, or equal, to a maximum depth of 1/4-inch, followed by packer wheels or drag chains to provide smooth finish.
   2. Seed at the rates specified below.
   3. Seed in 2 passes at right angles to one another.
   4. Sow half the seed in each pass.
   5. Provide markers or other means to ensure that the successive seeded strips will overlap or be separated by a space no greater than the space between the rows planted by the equipment being used.
   6. Do not seed during windy weather.
   7. Restore fine grade after seeding as requested by the Engineer.
   8. Remove irregularities by hand raking or rolling.
   9. In areas inaccessible to a drill seeder, broadcast seed by hand in 2 opposite directions.
      a. Rake in seed after broadcasting.
      b. Do not broadcast seed during windy weather.
   10. Seeding rates:
      a. Shall be as recommended by the seed supplier for drill seeded areas.
      b. Hand and broadcast seeded areas shall receive 2 times the seeding rate indicated.
   11. Do not seed areas in excess of that which can be mulched on same day.
   12. Do not sow immediately following rain, when ground is too dry, frozen, or during windy periods.
   13. Roll seeded area with roller not exceeding 100 pounds.
   14. Immediately following seeding and compacting, apply mulch.
   15. Sow seed with spreader or seed drill machine.
      a. Do not broadcast or drop seed when wind velocity exceeds 5 miles per hour.
      b. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
         1) Do not use wet seed or seed that is moldy or otherwise damaged.
         2) Do not seed against existing trees.
            a) Limit extent of seed to outside edge of planting saucer.
   16. Sow seed at a total rate as recommended by the seed supplier.
   17. For any broadcast seeded areas, rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
   18. Protect seeded areas with erosion-control mats where indicated on the Drawings; install and anchor according to the manufacturer's written instructions.
   19. In final preparations for seeding, use level board not less than 8 feet in length to ensure true and accurate grades.
   20. Finish grade lawn areas to 2-inches below elevation of adjacent paving.
   21. Do not take heavy objects, except lawn rollers, over areas that have been prepared for seeding.
   22. Prior to seeding, the Engineer shall accept areas for grade and compaction.

C. Seed establishment on slopes:
   1. Protect seeded areas with slopes and swales exceeding 1:4 with erosion control blankets installed and stapled according to the manufacturer's written instructions.

2. Roll fabric onto slopes without stretching or pulling.
3. Lay fabric smoothly on surface in direction of water flow.
    a. Bury top end of each section in 6-inch deep excavated topsoil trench.
    b. Provide 6-inch overlap of adjacent rolls.
    c. Backfill trench and rake smooth, level with adjacent soil.
4. Secure outside edges and overlaps at 24-inch intervals with stakes.
5. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
6. For sides of ditches, lay fabric laps in direction of water flow.
    a. Lap ends and edges minimum 6 inches.

D. Satisfactory seed areas:
1. Turf installations shall meet the following criteria as determined by the Engineer:
    a. Acceptance for soil preparation (topsoil installation) and final grading shall be given by the Engineer upon satisfactory completion of each section or area prior to seeding.
    b. Final completion for seeded areas shall be given by the Engineer as soon as there is an even stand of grass with germination over 100 percent of the Site.
        1) Warranty:
            a) Guarantee seeding to be alive and healthy for 2 years following date of final completion by the Engineer.
            b) Seeded areas shall have an even stand of grass with germination, over 100 percent of the Site within 45 days of seeding.
            c) Seeded grass areas are to be ensured of obtaining a satisfactory stand of growth.
            d) Total area occupied by bare spots larger than 0.25 square feet must not exceed 10 percent of the total seeded area.
            e) Maximum single bare spot size of irrigated seed 3 inches by 3 inches.
            f) Maximum single bare spot size of non-irrigated seed is 1 square foot.
            g) Seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.
        2) Re-seed areas that, in the opinion of the Engineer, do not meet the preceding standards.
2. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

E. Seeded area maintenance:
1. Maintain and establish seeded area by watering, noxious weed management, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable seeded area.
    a. Roll, regrade, and replant bare or eroded areas and remulch.
    b. Provide materials and installation the same as those used in the original installation.
        1) Fill in as necessary soil subsidence that may occur because of settling or other processes.
            a) Replace materials and seeded area damaged or lost in areas of subsidence.

2) In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
3) Apply treatments as required to keep seeded area and soil free of pests and pathogens or disease.
a) Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

2. Watering: Install and maintain temporary piping, hoses, and seeded area watering equipment to convey water from sources and to keep meadow uniformly moist.
a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
1) Lay out temporary watering system to avoid walking over muddy or newly planted areas.
b. Water meadow with fine spray at a minimum rate of 1/2 inch per week or more for seed establishment for 6 weeks after planting or until seed establishment is determined by the Engineer (whichever is longer) unless rainfall precipitation is adequate.

3.07 MULCH

A. Straw mulch:
1. After seeding, apply 2 tons of small-grained straw per acre.
a. Spread straw to give a 1/2-inch to 1-inch thick layer of mulch (3 to 5 straws thick) and crimp in 2 to 3 inches with a mechanical crimper or other approved equipment.
2. Hand crimping shall be employed in areas inaccessible to crimper, or where excessive slopes would cause unsatisfactory results.
3. Crimping against the contour shall not be accepted.
4. Apply water and tackifier with a fine spray immediately after each area has been mulched.
a. Saturate to 4 inches of soil.

3.08 HYDRO-MULCH

A. Hydro-mulch dormant seeded areas with a slurry mix containing additional tackifier.

B. Utilize hydraulic equipment with nozzle adapted for hydraulic mulching with storage tanks having means of estimating volume used or remaining in the tank.

C. Shall consist of tackifier applied at a rate of 100 pounds per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,200 pounds per acre.
1. Hydro-mulch applied to dormant seeded areas shall consist of tackifier applied at a rate of 150 pounds per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,200 pounds per acre.

D. Protect seeded areas with slopes not exceeding 1:4 by spreading straw mulch.
1. Spread uniformly at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.

2. Spread by hand, blower, or other suitable equipment.
    a. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
    b. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gallons per 1,000 square feet.
        1) Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas.
        2) Immediately clean damaged or stained areas.

E. Protect seeded areas from hot, dry weather or drying winds by applying hydro mulch and tackifier within 24 hours after completing seeding operations.
    1. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

3.09 HYDROSEED

A. Installation:
    1. Surface preparation:
        a. Area to be hydroseeded to be weed free and have a firm seed bed which has previously been roughened by scarifying, disking, harrowing, chiseling, or otherwise worked to a depth of 2 to 4 inches.
        b. Do not use any implements that will create an excessive amount of downward movement or clods on sloping areas.
        c. Hydroseed bed may be prepared at time of completion of earthmoving work.
    2. Application:
        a. Mark test plots to calibrate equipment and rate of vehicle.
            1) Continue test operations until satisfied with performance of even, smooth application.
        b. Apply seed with wood cellulose fiber at 500 pounds per acre.
            1) Do not allow seed to stay within slurry longer than 30 minutes.
        c. Immediately after seeding, apply wood fiber mulch at 3,000 pounds per acre with a tackifier adhesive at 75 pounds per acre.
            1) Mixture to be sufficient green in color to determine coverage.
            2) Use nontoxic dye that is water-soluble.
        d. Foot traffic on hydroseed is not permitted.
    3. Slurry preparation:
        a. Prepare slurry at the Project Site using potable water.
        b. Dispose of any slurry that has not been used within 2 hours at a location off-site at the Contractor’s expense.

B. Watering:
    1. Provide temporary watering system or apply water with a water truck acceptable to the Engineer.
        a. Plant effluent may be used for hydroseed watering.
        b. Do not place irrigation lines on top of embankment slope.

2. Germination stage:
    a. Initiate watering sequence within 24 hours after hydro-mulching planted areas.
        1) Leave water on long enough to moisten soil thoroughly to a depth of the fiber, taking care not to supersaturate or wash fiber or soil particles off the slopes.
        2) Observe irrigation system continually while in operation.
    b. Repair seed washing or erosion immediately.
    c. Irrigate fiber and seed lightly and frequently to maintain optimum moisture content for maximum germination. Determine irrigation sequence according to air temperature, prevailing wind velocity, soil texture, orientation, and other logistical problems.
    d. Keep soil moist at all times during germination period. Continue irrigation sequence until seedlings have grown beyond the germination stage, approximately 30 to 60 days.

C. Establishment stage:
    1. Reduce watering frequency while increasing duration of the water sufficiently to allow for maximum water penetration for the expanding root system. Take care not to cause erosion.
    2. Precise watering reduction program to be determined by the Contractor.

D. Hardening-off stage:
    1. Reduce irrigation frequency while increasing the duration of each water cycle.
    2. A specific watering program to be approved by the Owner.

E. Fertilizer:
    1. Distributed uniformly over seed bed and incorporated into the soil. Incorporation may be part of the seed bed preparation or as part of the seeding operation, unless seed is broadcast.
        a. If fertilizing is a part of the seed bed preparation, do not fertilize more than 15 days prior to seeding.
    2. Apply fertilizer at 250 pounds per acre.

F. Mowing:
    1. Mow seeded areas prior to spring germination.

G. Maintenance:
    1. Maintain hydroseed areas for 1 year following final acceptance.
    2. Involves watering, mowing, and any other activities required to establish and maintain the ground cover.

3.10 EROSION CONTROL BLANKETS

A. Preparation for erosion-control materials:
    1. Install erosion-control materials in accordance with the manufacturers' recommendations.
    2. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by the material manufacturer for Site conditions.
        a. Fasten as recommended by the material manufacturer.

3. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
4. Erosion control hydroseeding to be applied to exterior slopes of the sludge and scum bed dikes, and to the interior slopes of the stormwater retention basin, as indicated on the Drawings.
    a. Hydroseeding shall be the last activity conducted by the Contractor prior to Project acceptance.
5. Moisten prepared area before planting if surface is dry.
6. Water thoroughly and allow surface to dry before planting.
7. Do not create muddy soil.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas.
    1. Clean wheels of vehicles before leaving Site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly seeded areas from traffic.
    1. Maintain fencing and barricades throughout initial seed establishment.

C. Remove nondegradable erosion-control measures after grass establishment period.

D. During landscape installation:
    1. Areas shall be reasonably clean at the end of each workday.
    2. Sidewalks and other paved areas shall be swept or washed down as needed.

E. Project completion:
    1. Debris, soil, and trash resulting from landscape operations shall be removed from the Site.
    2. Paved areas shall be washed down.

END OF SECTION

SECTION 02952

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

1.02 SUBMITTALS

A. Mix designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Limiting dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

2.02 MATERIALS

A. Aggregate base course: As specified in Section 02050 - Soil Aggregates and for Earthwork.

B. Asphalt pavement: As specified in Section 02742 - Asphaltic Concrete Paving.

C. Portland cement concrete replacement material: Class A concrete as specified in Section 03300 - Cast-in-Place Concrete.

2.03 EQUIPMENT

A. Roads, pavements, parking areas, and walks:
   1. Equipment requirements: Good condition, capable of performing work intended in satisfactory manner.

2.04 ACCESSORIES

A. Material for painting asphalt concrete pavement: Tack coat as specified in Section 02742 - Asphaltic Concrete Paving.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate surface removal replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement removal and temporary asphalt replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to centerline of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt pavement replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of Engineer.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.
   4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland cement concrete pavement replacement:
   1. Where trenches lie within portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.

2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.
3. Provide expansion joints that match existing.
4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
5. Surface finish: Wood float finish.

E. Curb, gutter, and sidewalk replacement:
1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed:
a. Provide expansion joints of same spacing and thickness as original construction.

F. Asphalt pavements:
1. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.
2. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements.
3. No extra payment will be made for these items and costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
1. Asphalt concrete as specified in Section 02742 - Asphaltic Concrete Paving.
2. Concrete as specified in Section 03300 - Cast-in-Place Concrete.

B. Inspection:
1. Asphalt concrete:
a. Lay 10-foot straightedge parallel to centerline of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.
2. Portland cement concrete replacement pavement:
a. Lay 10-foot straightedge either across pavement replacement or longitudinal with centerline of gutter or ditch.
b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 03055

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

A. American Concrete Institute (ACI).
   1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

C. ASTM international (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   2. E488 - Standard Test Method for Strength of Anchors in Concrete Elements.

D. Concrete Reinforcing Steel Institute (CRSI).

E. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

G. Society for Protective Coatings (SSPC):
   1. SP-1 - Solvent Cleaning.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the building code specified in Section 01410 - Regulatory Requirements.

1.04 SUBMITTALS

A. Submit in accordance with Section 01330 - Submittal Procedures.

B. Product data: Technical data for adhesives, including:
   1. Manufacturer's printed installation instructions (MPII).
   2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
   3. Handling and storage instructions.
   4. Evidence of current listing under NSF-61 for use in contact with potable water.

C. Quality control Submittals:
   1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01410 - Regulatory Requirements.
   2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
   3. Installer qualifications:
      a. Submit evidence of successful completion of adhesive manufacturer's installation training program.
      b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.

D. Inspection and testing reports:
   1. Inspections: Field quality control: Reports of inspections and tests.
      a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installation requirements:
      a. Have available at the site, and install anchors in accordance with, the adhesive manufacturer's printed installation instructions.
   2. Installer qualifications:
      a. Demonstrating successful completion of adhesive manufacturer's on-site training program for installation of adhesive-bonded anchors.
      b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the Building Official.
         1) Organizations/certification programs deemed to be qualified are:
            a) ACI-CRSI Adhesive Anchor Installer Certification Program.
            b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the Building Official.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
   1. Store adhesives and adhesive components on pallets or shelving in a covered storage area protected from weather.
   2. Control temperature to maintain storage within manufacturer's recommended temperature range.
      a. If products have been stored at temperatures outside manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
   3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

A. As specified in Section 01850 - Design Criteria.

B. Seismic Design Category (SDC) for structures: As specified in Section 01850 - Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

B. Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements of ACI 355.4 and ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.

C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

D. For locations where adhesive will be in direct contact with potable water in the finished work, provide documentation of testing and listing under NSF-61. Testing shall be by a nationally recognized agency acceptable to the Engineer.

2.02 EPOXY ADHESIVE

A. Materials:
   1. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   2. Two-component, 100 percent solids, insensitive to moisture.
   3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer’s static mixing nozzle.
      a. Use a nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
   2. Container markings: Include manufacturer’s name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-RE 500-V3.
   2. Simpson Strong-Tie Co., Inc., SET-3G.

2.03 ACRYLIC AND HYBRID ADHESIVE

A. Materials for cold-weather adhesive conditions:
   1. 2-component, high-solids, acrylic-based or hybrid acrylic and epoxy-based adhesive.
   2. Approved by the manufacturer for installation at substrate temperatures of 0 degrees Fahrenheit and above.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Use a nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-HY 200-A V3.
   2. Simpson Strong-Tie Co., Inc., AT-3G.

2.04 ALL THREAD RODS

A. Materials: As specified in Section 05120 - Structural Steel Framing for rods, nuts and washers.

2.05 REINFORCING BARS

A. As specified in Section 03200 - Concrete Reinforcing.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official.
   1. Do not install holes or adhesive until training is complete.

B. Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.

C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
   1. If embedment depth is not indicated, contact the Engineer for requirements.
   2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by the Engineer.

3.02 PREPARATION

A. Do not begin installation of adhesive bonded anchors until:
   1. Concrete has achieved an age of at least 21 days after placement.
   2. On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.

B. Review manufacturer's printed installation instructions (MPII) and "Conditions of Use" stipulated in the Evaluation Report before beginning work.
   1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents and resolve before proceeding with installation.

C. Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

D. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.

2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by the Engineer.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
      a. Installation of anchors in cored holes is not permitted.
      b. Set drill to “rotation only” mode, or to “rotation plus hammer” mode in accordance with the manufacturer’s installation instructions and the requirements of the Evaluation Report.
      c. Where edge distances are less than 2 inches and “rotation plus hammer” mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
   2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a “condition of use” in the Evaluation Report.
      a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer’s installation instructions and the Evaluation Report.

D. Hole depth: As recommended in the manufacturer’s installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by the Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
      a. Obtain Engineer’s acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
      b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
      c. Epoxy grout may be substituted for dry-pack mortar when accepted by the Engineer.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
   3. When existing reinforcing steel is encountered during drilling and when specifically accepted by the Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
   4. Bent bar reinforcing bars: Where edge distances are critical and interference with existing reinforcing steel is likely, if acceptable to the Engineer, drill hole at 10-degree (or less) angle from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
   1. Insert air nozzle to bottom of hole and blow out loose dust.
      a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
      b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
   2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
      a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
      b. Repeat at least 4 times.
   3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
   4. Leave prepared holes clean and dry.
   5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
   6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
   2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
   1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
   2. Fill hole as nozzle is withdrawn without creating air voids.
   3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
   4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods.
   1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
   2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer’s recommended procedures.
   3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
   4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
   5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading.
   1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
   2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
   1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
   2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel-to-steel connections.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01450 - Quality Control.

B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
   1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
      a. Provide notice of scheduled training to the Engineer and to special inspector(s) not less than 10 working days before training occurs. Engineer and special inspector may attend training sessions.
   2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
   1. Hole drilling and preparation.
   2. Results: Submit records of inspections and testing to the Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455 - Regulatory Quality Assurance.

2. Frequency of inspections:
    a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
    b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
    c. Provide continuous inspection of drilling, cleaning and bonding activities for bars and rods installed in horizontal and upwardly inclined positions.
3. Preparation:
    a. Review Drawings and Specifications for the Work to be observed.
    b. Review adhesive manufacturer's MPII and recommended installation procedures.
    c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
4. Inspection: Periodic:
    a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
        1) Concrete: Class (minimum specified compressive strength) and thickness.
        2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
        3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "Conditions of Use" listed in the Evaluation Report.
        4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
        5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
    b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
        1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
        2) For ongoing installations, the special inspector visits the site at least once for every 4 hours of work during each day of installation to observe the work for compliance with material requirements and installation procedures.
5. Inspection: Continuous.
    a. Make observations as described under "Inspection - Periodic, Initial Inspection" during drilling, cleaning, and bonding activities for all bars and rods installed.

6. Records of inspections:
    a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
    b. Submit electronic copies of inspection reports to the Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product Data: Submit manufacturer's data completely describing epoxy materials:
   1. Submit evidence of conformance to ASTM C881. Include manufacturer’s designations of Type Grade, Class, and Color.
   2. Submit documentation that materials meet or exceed the specified strength and performance characteristics. Indicate test methods and test results.
   3. Submit documentation confirming listing under NSF-61.

C. Quality control Submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
   1. Provide epoxy materials that are new.
   2. Store and use products within limitations set forth by the manufacturer.
   3. Perform and conduct work of this Section in neat orderly manner.

2.02 MATERIALS

A. General:
   1. Moisture tolerant, water-insensitive, 2-component epoxy resin adhesive material containing 100 percent solids, and meeting or exceeding the performance properties specified when tested in accordance with the standards specified.
   2. Listed under NSF-61 for use in direct contact with potable water.

B. Epoxy: Low viscosity product in accordance with ASTM C881; Types I, II, and IV; Grade 1, except as modified in this Section.
   1. Manufacturers: One of the following, or equal:
      a. Dayton Superior, Unitex Pro-Poxy 100.
      b. Sika Corporation, Sikadur 35 Hi-Mod LV.
   2. Required properties:

Table 1. Material Properties - Epoxy		
Property	**Test Method**	**Required Results ("neat")**
Tensile Strength (7-day)	ASTM D638	7,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	10,000 pounds per square inch, minimum.
Bond Strength (harded concrete to harded concrete after 2-day cure)	ASTM C882	1,000 pounds per square inch, minimum. Concrete failure before failure of epoxy.
Viscosity (mixed)		250 to 550 centipoise
Notes: (1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

C. Epoxy gel: Non-sagging product in accordance with ASTM C881, Types I and IV, Grade 3.
   1. Manufacturers: One of the following, or equal:
      a. Sika Corp., Sikadur 31, Hi-Mod Gel.
   2. Required properties:

Table 2. Material Properties - Epoxy Gel		
Property	**Test Method**	**Required Results ("neat")**
Tensile Strength (7-day)	ASTM D638	2,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,000 pounds per square inch, minimum.
Bond Strength (14-day)	ASTM C882	1,500 pounds per square inch, minimum.
Notes: (1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

D. Epoxy bonding agent: Non-sagging product in accordance with ASTM C881, Type II, Grade 3.
   1. Manufacturers: One of the following, or equal:
   2. Sikadur 31 Hi-Mod Gel Required properties:

Table 3. Material Properties - Epoxy Bonding Agent		
Property	**Test Method**	**Required Results**
Tensile Strength (7-day)	ASTM D638	3,300 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,300 pounds per square inch, minimum.
Bond Strength (14-days)	ASTM C882	1,800 pounds per square inch, minimum. Concrete failure before failure of epoxy bonding agent.
Pot Life	-	Minimum 60 minutes at 72 degrees Fahrenheit.
Notes: (1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

   3. If increased contact time is required for concrete placement, epoxy resin/Portland cement bonding agent, as specified in Section 03072 - Epoxy Resin/Portland Cement Bonding Agent, may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03072

EPOXY RESIN/PORTLAND CEMENT BONDING AGENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy resin/portland cement bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
   2. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   3. C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   4. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

B. Federal Highway Administration (FHWA):
   1. FHWA-RD-86-193 - Highway Concrete Pavement Technology Development and Testing Volume V: Field Evaluation of SHRP C9206 Test Sites (Bridge Deck Overlays).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Sika Armatec 110.

B. Substitutions: The use of other than the specified product will be considered, providing the Contractor requests its use in writing to the Engineer. This request shall be accompanied by:
   1. A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds specified performance criteria, tested in accordance with the specified test standards.
   2. Documented proof that the proposed substitute product has a 1-year proven record of performance of bonding portland cement mortar/concrete to hardened portland cement mortar/concrete, confirmed by actual field tests and 5 successful installations that the Engineer can investigate.

2.02 MATERIALS

A. Epoxy resin/portland cement adhesive:
   1. Component "A" shall be an epoxy resin/water emulsion containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
   2. Component "B" shall be primarily a water solution of a polyamine.
   3. Component "C" shall be a blend of selected portland cements and sands.
   4. The material shall not contain asbestos.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. Properties of the mixed epoxy resin/portland cement adhesive:
   1. Pot life: 75 to 105 minutes.
   2. Contact time: 24 hours.
   3. Color: Dark gray.

B. Properties of the cured epoxy resin/portland cement adhesive:
   1. Compressive strength in accordance with ASTM C109:
      a. 3 day: 4,500 pounds per square-inch minimum.
      b. 7 days: 6,500 pounds per square-inch minimum.
      c. 28 days: 8,500 pounds per square-inch minimum.
   2. Splitting tensile strength in accordance with ASTM C496:
      a. 28 days: 600 pounds per square-inch minimum.
   3. Flexural strength:
      a. 1,100 pounds per square-inch minimum in accordance with ASTM C348.
   4. Bond strength in accordance with ASTM C882 modified at 14 days:
      a. 0 hours open time: 2,800 pounds per square-inch minimum.
      b. 24 hours open time: 2,600 pounds per square-inch minimum.
   5. The epoxy resin/portland cement adhesive shall not produce a vapor barrier.
   6. Material must be proven to prevent corrosion of reinforcing steel when tested under the procedures as set forth by the FHWA Program Report Number FHWA-RD-86-193. Proof shall be in the form of an independent testing laboratory corrosion report showing prevention of corrosion of the reinforcing steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mixing the epoxy resin: Shake contents of Component "A" and Component "B." Completely empty both components into a clean, dry mixing pail. Mix thoroughly for 30 seconds with a jiffy paddle on a low speed with 400 to 600 revolutions per minute drill. Slowly add the entire contents of Component "C" while continuing to mix for a minimum of 3 minutes and until uniform with no lumps. Mix only the quantity that can be applied within its pot life.

B. Placement procedure:
   1. Apply to prepared surface with stiff-bristle brush, broom, or "hopper-type" spray equipment:
      a. For hand applications: Place fresh plastic concrete/mortar while the bonding bridge adhesive is wet or dry, up to 24 hours.
      b. For machine applications: Allow the bonding bridge adhesive to dry for 12 hours minimum.

C. Adhere to all limitations and cautions for the epoxy resin/portland cement adhesive in the manufacturer's current printed literature.

3.02 CLEANING

A. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 03102

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

C. Underwriters Laboratories (UL).

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Green Concrete: Concrete with less than 100 percent of the minimum specified compressive strength (f'_c).

1.04 SUBMITTALS

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure themselves that intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be submitted.

B. Form release agent. NSF 61 certification prepared by NSF, Underwriters Laboratories (UL) or other, similar, nationally recognized testing laboratory acceptable to the Engineer.

1.05 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by manufacturers having a minimum of 5 years of experience, except as otherwise specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install work of this Section in accordance with local, state, and federal regulations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
   3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
   4. Use forms that are clean and free from dirt, concrete, and other debris.
      a. Coat with form release agent if required, prior to use or reuse.

2.02 MANUFACTURED UNITS

A. Forms: Built-up plywood:
   1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
      a. Size and material:
         1) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
         2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
      b. Wales: Minimum 2-inch by 4-inch lumber.
      c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
      b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
   2. Steel framed plywood forms:
      a. Provide forms that are rigidly constructed and capable of being braced.
      b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

C. Form release agent.
   1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.
   2. Certified for conformance to NSF 61 and leaving no taste or odor on the concrete surface.

D. Form ties:
   1. General:
      a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
      b. Do not use wire ties or wood spreaders of any form.
      c. Provide ties of type that accurately tie, lock, and spread forms.
      d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
      e. Do not allow holes in forms for ties to allow leakage during placement of concrete.
   2. Cone-snap ties:
      a. Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
      b. Provide neoprene waterseal washer that is located near the center of the concrete.
   3. Taper ties:
      a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

E. Incidentals:
   1. External angles:
      a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
      b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, and construction joints.
   2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:
   1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms: Built-up plywood:
   1. Studding:
      a. Spaced at 16 inches or 24 inches on center.
      b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
      c. Install studs perpendicular to grain of exterior plys of plywood sheets.
   2. Wales: Form wales of double lumber material with minimum size as specified in this Section.
   3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Adequately brace forms for minimum deflection of finish surface.
   2. Steel framed plywood forms:
      a. Rigidly construct and brace with joints fitting closely and smoothly.
      b. Number of form reuses: Depends upon durability of surface coating or overlay used.
   3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

C. Form bracing and alignment:
   1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
   2. Formwork:
      a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.
      b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.
   3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:
      a. Spreading and vertical or horizontal displacement of forms.
      b. Grout "bleeding" on finish concrete surfaces.
   4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.
   5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

D. Forms: Incidentals:
   1. Keyways: Construct as indicated on the Drawings.
   2. Reentrant angles: May be left square.
   3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.

4. Inserts:
    a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
5. Pipe and conduit penetrations:
    a. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 07900 - Joint Sealants.

E. Form release agent:
1. Apply in accordance with manufacturer's instructions.

F. Form ties:
1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally.

3.03 FORM REMOVAL

A. General:
1. Keep forms in place, as specified in the following paragraphs, to provide curing and to protect concrete surfaces and edges from damage.
2. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified.

B. Form removal:
1. Do not remove forms from concrete which has been placed when outside ambient air temperature is below 50 degrees Fahrenheit until the following conditions are satisfied:
    a. Concrete has sufficient strength to allow form removal without damage to surfaces.
    a. At least 48 hours have elapsed since the end of concrete placement.
    b. Provisions are in place to maintain moisture for curing concrete, and temperature at or above the required minimum curing temperature specified.
2. Vertical forms:
    a. Retain in place for a minimum of 24 hours after concrete is placed.
    b. If concrete has sufficient strength and hardness to resist surface or other damage after 24 hours, forms may be removed.
3. Other forms supporting concrete, and shoring: Retain in place as follows:
    a. Formed sides of footings: 24 hours minimum.
    c. Formed vertical sides of beams, girders, and similar members: 48 hours minimum.
    b. Forms below slabs, beams, and girders: Until concrete strength reaches specified strength f'c or until shoring is installed.
        1) Shoring for slabs, beams, and girders: Shore until concrete strength reaches minimum specified 28-day compressive strength.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03300 - Cast-in-Place Concrete.

B. Form ties: Remove form ties from surfaces. Fill tie holes as follows:
   1. Remove form ties from surfaces.
   2. Roughen cone shaped tie holes by heavy sandblasting before repair.
   3. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03600 - Grouting.
   4. Taper ties:
      a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
         1) Heavy sandblast and then clean tie holes.
         2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
         3) Locate steel rod in cylindrical recess and against middle of plug during driving.
            a) At no time are plugs to be driven on flat area outside cylindrical recess.
      b. Dry-pack of taper tie holes:
         1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03600 - Grouting.
            a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
            b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
            c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
               (1) Cover with minimum of 10 mils of epoxy gel.
               (2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.
               (3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 TOLERANCES

A. Finished concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct work within the tolerances in accordance with ACI 117, except as modified in the following paragraphs or as indicated on the Drawings.
   1. General:
      a. At certain locations in the Work, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements of this Section.
      b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.
   2. Slabs:
      a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
      b. Slabs indicated to be level: Have maximum vertical deviation of 1/8-inch in 10-foot horizontal length without any apparent changes in grade.

3. Circular tank walls:
   a. The Contractor may deviate from the finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.
4. Inserts and embedments:
   a. Set inserts and embedments to tolerances required for proper installation and operation of equipment or systems to which insert pertains.
   b. Maximum tolerances: As follows:

Item	Tolerance
Sleeves and inserts	Plus 1/8 Minus 1/8 inches.
Anchor bolts:	
Projected ends	Plus 1/4 Minus 0.0 inches.
Axial alignment	Not more than 2 degrees off the axis indicated on the Drawings.
Setting location	Plus 1/16 Minus 1/16 inches.
All embedments	Minimum 1 inch clearance from reinforcing steel.

   c. Securing embedded items in formwork by wiring or welding to reinforcement is not permitted.

C. Remove and replace work that does not conform to required tolerances. Procedures and products employed in and resulting from such re-work shall be acceptable to the Engineer.

END OF SECTION

SECTION 03150

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1.
   2. D570 - Standard Test Method for Water Absorption of Plastics.
   3. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   4. D638 - Standard Test Method for Tensile Properties of Plastics.
   5. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   6. D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   7. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   8. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   9. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   10. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.

B. American National Standards Institute (ANSI):
   1. A135.4 - Basic Hardboard.

C. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of Engineer.
   2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
   1. Use specific type in applications as indicated on the Drawings.
   2. Do not use scrap or recycled materials to manufacture joint fillers.

B. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width indicated on the Drawings.
         2) Asphalt-impregnated fiber in accordance with ASTM D1751.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Fibre Expansion Joint.
   2. Synthetic sponge rubber expansion joint material:
      a. Properties:
         1) Thickness: As recommended for width indicated on the Drawings.
         2) Material in accordance with ASTM D1752, Type I.
      b. Manufacturers: One of the following or equal:
         1) Williams Products Inc., Everlastic 1300.
         2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corp.
      b. Sika Corp., Greenstreak PVC Waterstop.
   3. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
      e. No scrap or reclaimed material shall be used.
   4. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D638	Not less than 300 percent.

Physical Characteristics	Test Method	Required Results
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 degrees Fahrenheit.
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
   1. General:
      a. Store waterstops to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints, where indicated on the Drawings.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.

e. Provide waterstops that are continuous.
f. Set waterstops accurately to position and line as indicated on the Drawings.
g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
k. Special clips may be used in lieu of wires, at Contractor's option.
l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.

2. Polyvinyl chloride waterstop:
   a. Install waterstops so that joints are watertight.
   b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
      1) Do not damage material by heat sealing.
      2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
      3) Maintain continuity of waterstop ribs and tubular center axis.
      4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.
   c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.

B. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings.
   2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

END OF SECTION

SECTION 03154

HYDROPHILIC RUBBER WATERSTOP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrophilic rubber waterstop.

1.02 REFERENCES

A. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. General:
   1. Submit the following items for each type, style and size of hydrophilic waterstop to be installed.
   2. Product data:
      a. Manufacturer’s product data sheets.
         1) Include complete physical dimensions, expansion characteristics, and laboratory test reports indicating that average material properties conform to the requirements specified.
         2) Provide data sheets for all materials to be included in the waterstop system.
   3. Samples:
      a. Minimum 6-inch long samples of each type of waterstop to be used if requested by the Engineer.
   4. Manufacturer's installation instructions:
      a. Installation instructions and recommended installation details for the complete waterstop system, and for each component used in that system.

PART 2 PRODUCTS

2.01 HYDROPHILIC RUBBER WATERSTOP

A. General:
   1. System composed of flexible hydrophilic urethane polymer with preformed strips, adhesives, paste, fasteners, and other accessories required for a complete and watertight installation.
      a. To ensure compatibility of materials, a single manufacturer shall provide all products and accessories for the hydrophilic waterstop system.
      b. Products incorporating bentonite are not acceptable under this Section.
      c. Provide waterstop and accessories resistant to degradation under cyclic wetting and drying.

B. Hydrophilic strip waterstop:
   1. Pre-formed strips of flexible hydrophilic rubber designed to undergo controlled expansion when exposed to moisture:
      a. Strips manufactured to limit expansion in directions parallel to the plane of the joint, and to direct expansion against confining material perpendicular to that plane.
   2. Provide normal or low-expansion pressure as scheduled and as indicated on the Drawings.
   3. Manufacturers: One of the following or equal:
      a. Hydrophilic strip:
         1) Adeka Ultra Seal USA, MC-2010MN.
         2) Sika Corp., Hydrotite CJ1020-2K.
      b. Low expansion hydrophilic strip:
         1) Adeka Ultra Seal USA, KBA-1510FP.
         2) Sika Corp., Hydrotite CJ0725-3K.

C. Hydrophilic paste waterstop.
   1. Single-component gun grade paste of hydrophilic rubber designed to undergo controlled expansion when exposed to moisture after initial curing.
   2. Manufacturers: One of the following or equal:
      a. Adeka Ultra Seal USA: P-201.
      b. Sika Corp., Leakmaster LV-Z.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and recommended details.

B. Prepare concrete joint surfaces:
   1. Use wire brushing or scraping to expose an uncontaminated, solid surface.
   2. Clean prepared surface with high-pressure air or water to remove residue and debris.
   3. Confirm that prepared surfaces conform to manufacturer’s recommendations for surface profile and moisture conditions before installing materials.

C. Provide manufacturer’s recommended lap, splice, and corner details for hydrophilic waterstops.
   1. Use hydrophilic paste at all corner joints and overlap splices of hydrophilic strips.

D. Hydrophilic strip waterstop:
   1. Install primers and adhesives when recommended by the manufacturer before setting hydrophilic strips.
   2. Keep hydrophilic strip taut during the fastening process.
   3. Secure hydrophilic strip in place with concrete nails, screws, or adhesive.

4. Provide installation with no gap between the hydrophilic strip and the concrete to which it is attached. At rough or irregular surfaces, set hydrophilic strip waterstop strip in a bead of hydrophilic paste.
    a. Fill all voids and rough areas under the hydrophilic strip with hydrophilic paste.
    b. Allow hydrophilic paste to cure in accordance with manufacturer's recommendations before encapsulating paste in fresh concrete.

3.02 SCHEDULE

A. At the following joint locations/conditions, use the hydrophilic strip waterstop configuration noted unless otherwise indicated on the Drawings.

B. Concrete construction joints:
    1. Under all of the following conditions, use hydrophilic strip waterstop set in a bed of hydrophilic paste waterstop, and screw strip waterstop to concrete surface:
        a. Slab or wall thickness is greater than 10 inches.
        b. Waterstop is placed between 2 rows of steel reinforcement.
        c. The concrete cover from waterstop to nearest concrete face is at least 4 inches.
    2. Under any one of the following conditions, use low-expansion hydrophilic strip waterstop set in bed of hydrophilic paste waterstop and screw strip to concrete surface:
        a. Waterstop is placed on 1 side of a single row of steel reinforcement.
        b. The concrete cover from waterstop to nearest concrete face is less than 4 inches.

C. Pipe penetrations through concrete:
    1. Pipe diameter less than 4 inches: Not allowed.
    2. Pipe diameter of 4 to 24 inches: Continuous bead of hydrophilic paste waterstop, minimum 1/4-inch high by 1/2-inch wide, encircling pipe.
    3. Pipe diameter greater than 24 inches: Continuous hydrophilic strip waterstop around perimeter of pipe, with hydrophilic paste seal at lapped ends of strip.

END OF SECTION

SECTION 03200

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Reinforcing bars.
      a. Carbon steel.
   2. Thread bars.
   3. Bar supports.
   4. Tie wires.
   5. Mechanical reinforcing bar couplers.
   6. Mechanical reinforcing bar end anchors (terminators).

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.
   2. SP-66 - ACI Detailing Manual.

B. American Iron and Steel Institute (AISI).

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

D. ASTM International (ASTM):
   1. A493 - Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   2. A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   3. A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   4. A1064 - Standard Specification of Carbon-Steel wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

E. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.

F. ICC Evaluation Service (ICC-ES):
   1. AC133 - Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcing Bars.
   2. AC347 - Acceptance Criteria for Headed Deformed Bars.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Architectural concrete: Concrete surfaces that will be exposed to view in the finished work.
      a. Additionally, for purposes of this Section, includes:
         1) Concrete surfaces that are designated to receive paints or coatings.
         2) Exposed concrete in open basins, channels, and similar liquid containing structures: Surfaces shall be considered exposed to view if located above a line 2 feet below the normal operating water surface elevation in that structure.
   2. Bars: Reinforcement or reinforcing bars as specified in this Section.
   3. Evaluation Report: Report prepared by ICC-ES, or by other testing agency acceptable to the Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.
   4. Give away bars: Reinforcing bars that are not required by the Contract Documents but are installed by the Contractor to provide support for the required reinforcing bars.
   5. Wire supports: Metal reinforcing supports constructed of steel wire as specified. Includes individual high chairs, continuous high chairs, bolsters and other similar configurations and shapes.

1.04 SUBMITTALS

A. General:
   1. Submit in accordance with Section 01330 - Submittal Procedures.
   2. Changes to reinforcement in Contract Documents:
      a. Indicate in a separate letter submitted with Shop Drawings any changes to reinforcement indicated on the Drawings or specified.
      b. Such changes will not be acceptable unless the Engineer has accepted them in writing.

B. Product data:
   1. Bar supports:
      a. Wire bar supports:
         1) Schedule of support materials to be provided and locations of use.
      b. Precast concrete bar supports (“dobies”):
         1) Manufacturer's data indicating compression strength of concrete and confirming dimensions and thickness(es) and height(s) to be provided for each location where used.
   2. Mechanical reinforcing bar couplers. For each type and/or series to be provided:
      a. Evaluation Report documenting compliance with the requirements of ICC-ES AC133.
      b. Details, properties, and dimensions of couplers. Include type or size identification, and bar size(s) and grade(s) for which the coupler is suitable.
      c. Manufacturer’s installation and testing instructions.

d. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

3. Mechanical reinforcing bar end anchors (terminators).
   a. Evaluation Report documenting compliance with the requirements of ICC-ES AC307.
   b. Details, properties, and dimensions of end anchors. Include type or size identification, and bar size(s) and grade(s) for which the end anchor is suitable.
   c. Manufacturer’s installation and testing instructions.
   d. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

C. Shop Drawings:
   1. Reinforcement Shop Drawings:
      a. Submit Drawings showing bending and placement of reinforcement required by the Contract Documents.
      b. Provide CAD generated Shop Drawings.
      c. Clearly indicate structures or portions of structures covered by each Submittal.
      d. Shop Drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and be in accordance with ACI SP-66.
      e. Use the same bar identification marks on bending detail Drawings, placement Drawings, and shipping tags.
      f. Submittals consisting solely of reinforcing bar schedules, without accompanying placement Drawings, will not be accepted unless accepted under prior written agreement with the Engineer.
   2. Reinforcement placement Drawings:
      a. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
      b. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
      c. Show anchor bolt locations based on anchor bolt templates for approved equipment.
      d. Show splice locations.
      e. Show locations of mechanical reinforcing couplers if used.
      f. Show locations of reinforcing bar end anchors, if used.
   3. Reinforcement fabrication Drawings:
      a. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations.
      b. Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

D. Samples (when requested by the Engineer):
   1. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.
   2. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

E. Test reports:
   1. Certified copy of mill test for each steel used. Show physical properties and chemical analysis.
      a. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.
      b. In such cases, submit certificates under the Shop Drawing Submittal number with the letter “R” (for record date) appended to the end (e.g., if the reinforcement was submitted as 03200-002-1, deliver the associated mill certificate as Submittal 03200-002-1R).
   2. Mechanical reinforcing bar couplers:
      a. Current Evaluation Report confirming that couplers provide specified tension and compression strength and conform to specified limits on total slip within the coupler.
      b. Certified copy of mill tests for heat(s) of steel incorporated into the reinforcing bar couplers shipped.
      c. For threaded sleeve type couplers, heat treatment lot numbers for each shipment.
   3. Reinforcing bar end anchors:
      a. Current Evaluation Report confirming that end anchors provide specified tension strength.
      b. Certified copy of mill tests for heat(s) of steel incorporated into the materials shipped.

F. Manufacturer's instructions:
   1. Mechanical reinforcing bar couplers:
      a. Manufacturer's installation instructions.
      b. Manufacturer's instructions for confirmation testing of couplers after reinforcing bars have been inserted into the couplers.
   2. Mechanical reinforcing bar end anchors:
      a. Manufacturer's installation instructions.
      b. Manufacturer's instructions for confirmation testing of end anchors.

G. Special procedures:
   1. Welding procedures in accordance with AWS D1.4 for reinforcement to be field welded.
      a. Procedures qualification record.

H. Qualifications statements:
   1. Welder qualifications.

I. Closeout documents:
   1. Field quality control and inspection reports.
   2. Field quality assurance special inspection and testing reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:
   1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks with letter containing manufacturer's guarantee of grade.

1.06 SEQUENCING AND SCHEDULING

A. Bar supports:
   1. Do not place concrete until samples and product data for bar supports have been accepted by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Drawings contain notes describing the size and spacing of reinforcement and its placement, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete, and other related information.

2.02 MATERIALS

A. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.
   2. ASTM A615 Grade 60 deformed bars, including the following requirements, or ASTM A706 Grade 60 deformed bars:
      a. Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
      b. Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
   3. Reinforcing bars designated or required to be welded:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.
      b. ASTM A615 Grade 60 deformed bars may be used in lieu of ASTM A706 Grade 60 if the following requirements are satisfied:
         1) Welding procedures in accordance with AWS D1.4 are submitted to the Engineer.
         2) The specific location for proposed substitution is acceptable to the Engineer.
   4. Reinforcing bars that are required to resist earthquake-induced flexural and axial forces in concrete frame members and in concrete shear wall boundary members where indicated on the Drawings:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.
      b. ASTM A615 Grade 60 may be used in lieu of ASTM A706 Grade 60 if the following requirements are satisfied:
         1) Mill certificates demonstrating following are submitted to the Engineer:
            a) Actual yield strength based on mill tests does not exceed minimum yield strength specified in this Section by more than

18,000 pounds per square inch. Retests shall not exceed this value by more than an additional 3,000 pounds per square inch.

b) Ratio of ultimate tensile strength to actual tensile yield strength based on mill tests of reinforcing bars shall not be less than 1.25.

2) The specific location for proposed substitution is acceptable to the Engineer.

B. Bar supports:
   1. Wire supports:
      a. All stainless steel bar supports:
         1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire in accordance with ASTM A493, AISI Type 316.
      b. Stainless steel protected bar supports:
         1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from cold-drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.
         2) Stainless steel wire ends shall be in accordance with ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.
      c. Bright basic wire bar supports.
         1) Conforming to CRSI Manual if Standard Practice, Class 3.
   2. Plastic supports:
      a. Manufacturers: The following or equal:
         1) Aztec Concrete Accessories.
   3. Deformed steel reinforcing bar supports:
      a. Fabricated of materials and to CRSI details recommended for typical reinforcement embedded in concrete and bent to dimensions required to provide specified clearances and concrete cover.
   4. Precast concrete bar supports (“dobies”):
      a. Pre-manufactured, precast concrete blocks with cast-in annealed steel wires, 16-gauge or heavier.
      b. Compression strength of concrete: Equal to or exceeding the compression strength of the surrounding concrete.
      c. Block dimensions:
         1) Height to provide specified concrete cover.
         2) Footprint not less than 3 inches by 3 inches, and adequate to support the weight of the reinforcement and maintain specified concrete cover without settling into the underlying surface.

C. Tie wires:
   1. General use: Black annealed steel wire, 16-gauge or heavier.

D. Welded wire fabric reinforcement:
   1. Material:
      a. Carbon steel in accordance with ASTM A1064.
   2. Provide welded wire reinforcement in flat sheet form. Rolled wire fabric is not permitted.

3. Fabric may be used in place of reinforcing bars if accepted by the Engineer:
    a. Provide welded wire fabric having cross-sectional area per linear foot not less than the cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

E. Mechanical reinforcing bar couplers and end anchors:
    1. General:
        a. Only products in accordance with the requirements of ACI 318 for mechanical splices and holding a current Evaluation Report that documents the following performance characteristics, will be considered for use.
        b. Strength of coupler: Capable of developing tension and compression strength not lower than the lesser of the following:
            1) ACI 318 “Type 2” units: In static tension and compression:
                a) Minimum 125 percent of the ASTM-specified minimum yield strength of the reinforcement being spliced or terminated.
                b) Minimum 100 percent of the ASTM-specified minimum ultimate strength of the reinforcement being spliced or terminated.
        c. Slip of reinforcing bars within coupler: Total slip of the reinforcing bars within the splice sleeve limited as follows:
            1) For bar sizes #14 and smaller, elongation between gauge points measured clear of the splice sleeve not exceeding 0.010 inches after coupler has been loaded to a tension of 30,000 pounds per square inch and load relaxed to a tension of 3,000 pounds per square inch.
        d. Fabrication:
            1) Threaded joints:
                a) Provide threaded ends designed so that cross-threading of bars will not occur during assembly.
                b) Fabricate male ends for female couplers using coupler manufacturer’s bar threading equipment to ensure proper taper and thread engagement.
            2) Mark each sleeve with heat treatment lot number.

2.03 FABRICATION

A. Shop fabrication and assembly:
    1. Cut and bend bars in accordance with provisions of ACI 318 and the CRSI Manual of Standard Practice.
    2. Bend bars cold. Use bending collars to develop the recommended bend radius.
    3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.
    4. Circumferential and radiused reinforcement: Roll to the radius required for its location in the structure before installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Reinforcing bars and welded wire reinforcement:
      a. Verify that reinforcement is new stock, free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings that will adversely affect bonding capacity when placed in the Work.
   2. Welded wire fabric:
      a. Verify that sheets are not curled or kinked before or after installation.

3.02 PREPARATION

A. Surface preparation:
   1. Reinforcing bars - uncoated:
      a. Clean reinforcement of concrete, dirt, oil and other coatings that will adversely affect bond before embedding bars in subsequent concrete placements.
      b. A thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean bars having rust scale, loose mill scale, or thick rust coat.
      c. Partially embedded reinforcement: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placements.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Field-cutting of reinforcing bars is not permitted.

Table 1. Reinforcement Placing Tolerances

Member	Tolerance on Reinforcement Location (1)	Tolerance on Minimum Concrete Cover (1,2)
Slabs, beams, walls and columns except as noted below:		
10 inches thick and less	± 3/8 inch	- 3/8 inch
More than 10 inches thick	± 1/2 inch	- 1/2 inch
Formed soffits	As noted above	- 1/4 inch
Longitudinal location of bends and ends of reinforcement:		
Conditions not listed below	± 2 inches	- 1/2 inch
At discontinuous ends of brackets and corbels	± 1/2 inch	- 1/4 inch
At discontinuous ends of other members	± 1 inch	- 1/2 inch

Table 1. Reinforcement Placing Tolerances		
Member	**Tolerance on Reinforcement Location (1)**	**Tolerance on Minimum Concrete Cover (1,2)**
Notes: (1) ± indicates "plus or minus;" - indicates "minus;" + indicates "plus." (2) Tolerance on cover is limited as noted but decrease in cover shall not exceed one third of the minimum cover indicated on the Drawings.		

2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements indicated on the Drawings and specified. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.
   3. Spacing between bars:
      a. Minimum clear spacing between bars in a layer:
         1) As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      b. Minimum clear spacing between bars in 2 or more parallel layers:
         1) Place bars in upper layers directly above bars in lower layers.
         2) Minimum spacing between layers: As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.
   4. Lap splices for bars:
      a. Lap splice locations and lap splice lengths: As indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.
      b. Unless otherwise specifically indicated on the Drawings (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.
      c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.
      d. Stagger lap splices where indicated on the Drawings.
      e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
   1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces.
      a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
   2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.

3. Do not use “give away bars” that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for giveaway bars.
4. Provide bar supports of height required to maintain the clear concrete cover indicated on the Drawings.
5. Provide bar supports at formed vertical faces to maintain the clear concrete cover indicated on the Drawings.
6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

Table 2. Reinforcement Support Materials

Case	Location	Material
a.	Concrete placed over earth and concrete seal slabs (“mud mats”)	Precast concrete bar supports.
b.	Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings)	All stainless steel bar supports.
c.	Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work	All stainless steel bar supports.
d.	Concrete placed against forms and exposed to interior equipment/piping areas in the finished work	All stainless steel bar supports.
e.	Between mats of reinforcement, and fully embedded within a concrete member	Bright basic wire bars supports, or deformed steel reinforcing bars.

D. Tying of reinforcing:
1. Fasten reinforcement securely in place with wire ties.
2. Tie reinforcement at spacings sufficient to prevent shifting.
   a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
3. Tie slab bars at every intersection around perimeter of slab.
4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

Table 3. Maximum Spacing of Tie Wires for Reinforcement

Bar Size	Slab Bar Spacing (inches)	Wall Bar Spacing (inches)
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

5. After tying:
   a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.

b. Remove tie wire clippings from inside forms before placing concrete.

E. Welded wire fabric reinforcement:
   1. Install only where indicated on the Drawings or accepted in advance by the Engineer.
   2. Install necessary tie wires, spacing chairs, and supports to keep welded wire fabric at its designated position in the concrete section while concrete is being placed.
   3. Straighten welded wire fabric to make sheets flat in the Work.
   4. Do not allow wire fabric to drape between supports unless such a configuration is specifically indicated on the Drawings.
      a. If fabric is displaced during placement of concrete, make provisions to restore it to the designated location using methods acceptable to the Engineer.
   5. Bend welded wire fabric as indicated on the Drawings or required to fit Work.
   6. Lap splice welded wire fabric as indicated on the Drawings.
      a. If lap splice length is not indicated, splice in accordance with ACI 318, but not less than 1 1/2 courses of fabric or 8 inches minimum. Tie laps at ends and at not more than 12 inches on center.

F. Welding reinforcing bars:
   1. Weld only where indicated on the Drawings or where acceptance is received from the Engineer prior to welding.
   2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by the Engineer.
      a. Conform to requirements for minimum preheat and interpass temperatures.
   3. Submit:
      a. Welding procedures specification.
      b. Procedures qualification record.
      c. Welder qualification test record.
   4. Do not tack weld reinforcing bars except where specifically indicated on the Drawings.

G. Reinforcing bar mechanical couplers and end anchors:
   1. Install only at locations indicated on the Drawings or where prior approval has been obtained from the Engineer.
   2. Install in accordance with manufacturer's instructions and requirements of Evaluation Report.
      a. Make splices using manufacturer's standard equipment, jigs, clamps, and other required accessories.
      b. After assembly of the splice, tighten using torque load not less than that recommended by the manufacturer.
   3. Unless greater cover is indicated on the Drawings, provide clear cover from surface of concrete to outside face of couplers that is not less than the minimum concrete cover specified for typical reinforcement.
      a. If cover is less than required, contact the Engineer for evaluation of conditions before modifying locations of bars or placing concrete.
      b. Modifications to maintain or provide required concrete cover, such as addition of concrete; re-positioning of stirrups, ties, etc., may be completed only after approval by the Engineer.

3.04 FIELD QUALITY CONTROL

A. Provide quality control for the Work of this Section as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
   1. Submit records of inspections and testing to the Engineer in electronic format within 24 hours after completion.

C. Manufacturer's services:
   1. Furnish manufacturer's technical representative to conduct jobsite training regarding proper storage, handling, and installation of mechanical reinforcing bar couplers and bar end anchors for personnel who will perform the installation. Engineer may attend training session.

3.05 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections and tests:
   1. Provide as specified in Section 01455 - Regulatory Quality Assurance.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Building Code specified in Section 01410 - Regulatory Requirements.
   3. Preparation:
      a. Review Drawings and Specification for the Work to be observed.
      b. Review approved Submittals and Shop Drawings.
   4. Inspections: Special inspection shall include, but is not limited to, the following items:
      a. Reinforcement: General:
         1) Type (material) and location of reinforcement supports.
         2) Bar material/steel grade and bar size.
         3) Location, placement, and spacing of bars.
         4) Clear concrete cover over reinforcement.
         5) Lap splice: Location and lap length. Bars within tolerances for contact (unless non-contact splice is indicated on the Drawings.)
         6) Bar hooks and development lengths embedded within concrete sections as indicated on the Drawings.
         7) Reinforcement tired in position and tie wire legs turned inward toward the center of the concrete section.
      b. Reinforcement: Welding:
         1) Inspector qualification and inspections shall be in accordance with the requirements of AWS D1.4.
         2) Provide periodic inspection for:
            a) Weldability of reinforcement other than ASTM A706.
            b) Single pass fillet welds with thickness less than or equal to 5/16 inch.
         3) Provide continuous inspection for:
            a) Other welds.
            b) Welds at mechanical reinforcing bar couplers and end anchors.

4) In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods, including radiographic inspection.

5. Mechanical reinforcing bar couplers and end anchors:
   a. Special inspection shall include, but is not limited to, the following items:
      1) Coupler and end anchor model and identification.
      2) Couplers and end anchors are installed in accordance with the requirements of the Engineering Report for each product.
      3) Confirmation of the following:
         a) Grade and size of reinforcing bars.
         b) Position of couplers and end anchors.
         c) Insertion length of reinforcement.
         d) Tightening of bars in the couplers and end anchors.
6. Records of inspections:
   a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
   b. Submit electronic copies of inspection reports to the Engineer within 24 hours after completion of inspections.

3.06 NON-CONFORMING WORK

A. Before placing concrete, adjust or remove and re-install reinforcement to conform to the requirements of the Contract Documents.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in-place concrete.

B. The requirements of this Section require advance planning for preparation and testing of trial batches. Review the mix design and testing requirements carefully, and schedule preparations and testing with sufficient time to complete tests, to obtain the Engineer's review of mixes and testing results, and to complete revisions and re-testing if required.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. CODE-318 - Building Code Requirements for Structural Concrete and Commentary.
   2. CODE-350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   3. PRC-212.3 - Report on Chemical Admixtures for Concrete.
   4. PRC-302.1 - Guide to Concrete Floor and Slab Construction.
   5. PRC-305 - Guide to Hot Weather Concreting.
   6. PRC-306 - Guide to Cold Weather Concreting.

B. ASTM International (ASTM):
   1. C29 - Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
   2. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. C33 - Standard Specification for Concrete Aggregates.
   4. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   5. C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   6. C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   7. C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   8. C94 - Standard Specification for Ready-Mixed Concrete.
   9. C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
   10. C117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
   11. C123 - Standard Test Method for Lightweight Particles in Aggregate.
   12. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   13. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   14. C138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

15. C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.
16. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
17. C150 - Standard Specification for Portland Cement.
18. C156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
19. C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
20. C171 - Standard Specifications for Sheet Materials for Curing Concrete.
21. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
22. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
23. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
24. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).
25. C295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
26. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
27. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
28. C494 - Standard Specification for Chemical Admixtures for Concrete.
29. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
30. C702 - Standard Practice for Reducing Samples of Aggregate to Testing Size.
31. C856 - Standard Practice for Petrographic Examination of Hardened Concrete.
32. C1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
33. C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
34. C1260 - Standard Test Method of Potential Alkali Reactivity of Aggregates (Mortar Bar Method).
35. C1293 - Standard Test Method for Determination of Length Change of Concrete due to Alkali-Silica Reaction.
36. C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
37. C1602 - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
38. C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete.
39. D75 - Standard Practice for Sampling Aggregates.
40. D2103 - Standard Specification for Polyethylene Film and Sheeting.
41. D3665 - Standard Practice for Random Sampling of Construction Materials.
42. D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

C. National Ready-Mixed Concrete Association (NRMCA).

D. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Alkali: The sum of sodium oxide and potassium oxide calculated as sodium oxide.
   2. Alkali load: Amount of alkalis contributed by the Portland cement in a concrete mixture, expressed in pounds per cubic yard (lb/yd^3) and calculated by multiplying the Portland cement content of the concrete in lb/yd^3 by the alkali content of the Portland cement, or the Portland cement portion of a blended cement, divided by 100.
   3. Architectural concrete: Concrete surfaces that will be exposed to view in the finished work.
      a. For purposes of this Section, includes only those surfaces that receive paint or coatings.
      b. Exposed concrete surfaces in open basins, channels, and similar liquid containing structures: Surfaces will be considered exposed to view if located above the water line as defined in Section 03366 - Concrete Finishes.
      c. Exterior concrete surfaces with portions above and below grade: Surface will be considered exposed to view of located above the grade line as defined in Section 03366 - Concrete Finishes.
   4. Average daily temperature: Calculated by summing hourly measurements of air temperature in the shade at the face of the concrete and dividing that sum by 24. In calculating the sum of the temperatures recorded, any measurement less than 50 degrees Fahrenheit shall be recorded as 0 degrees Fahrenheit and included in the sum.
   5. Cementitious materials: Portland cement and supplementary cementitious materials.
   6. Class of concrete: Refers to a mix with characteristics, proportions, and constituents (including a specific combination of admixtures) as specified in this Section.
      a. Any change in the source or characteristics of constituent materials, in the proportions of materials, or in the admixtures included in a mix shall be considered as creating a new and separate class of concrete.
      b. Any mix to be placed by pumping shall be considered as creating a new and separate class of concrete.
   7. Cold weather: Includes one or more of the following conditions:
      a. Current air temperature is 45 degrees Fahrenheit and falling.
      b. Air temperature during the first 24 hours after placement is expected to fall into the range of 45 degrees Fahrenheit to 40 degrees Fahrenheit.
      c. A period when, for more than 3 consecutive days, the following conditions exist:
         1) The average daily air temperature drops below 40 degrees Fahrenheit.
         2) The air temperature is not greater than 50 degrees Fahrenheit for more than one-half of any consecutive 24-hour period.
   8. Cold weather concreting: Operations for placing, finishing, curing, and protecting concrete during cold weather.
   9. Green concrete: Concrete that has not yet achieved 100 percent of the minimum specified compressive strength, f'c, for that mix.

10. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch (0.004 inches).
11. Hot weather: Any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.2 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI PRC-305 and in this Section, Attachment A - Menzel Formula and Nomograph.
12. Hot weather concreting: Operations for placing, finishing, curing, and protecting concrete during hot weather.
13. Paste content: The total concrete volume minus the volume of aggregate, expressed as a percentage of total volume. Paste volume includes volume of cementitious materials, water, air, admixtures materials, and any fibers.
14. Supplemental cementitious material: Inorganic material such as fly ash, natural pozzolans, silica fume, or slag cement that reacts pozzolanically or hydraulically.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Concrete mix designs.

1.05 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures.

B. General:
   1. Data for concrete mixes and mix constituents supplied to the Work shall be coordinated through a single supplier.
   2. A maximum of 2 mix designs will be reviewed by the Engineer for each class of concrete required.
      a. Review of additional mix designs shall be at the expense of the Contractor.

C. Product data:
   1. Submit data completely describing products and demonstrating compliance with the requirements of this Section.
   2. Data for all products in the mix for each class of concrete shall be submitted concurrently with that mix design.
   3. Where products conforming to NSF 61 are required, submit evidence of testing and listing under NSF 61 for use in direct contact with potable water. Testing and listing shall be by a nationally recognized agency acceptable to the Engineer.
   4. Admixtures:
      a. For each admixture included in concrete mixes, submit manufacturer’s product data demonstrating compliance with standards specified.
      b. If air entraining admixture requires test method other than ASTM C173 to accurately determine air content, make special note of requirements in Submittal.
   5. Curing compound: Submit complete data on proposed compound.

D. Delegated Design Submittals:
    1. Concrete mix designs:
        a. Submit full details, including mix design calculations and plots, for concrete mixes proposed for use for each class of concrete.
        b. Include mix design calculations of proportions by both weight and volume.
        c. Determine and include the alkali load of the proposed mix.
        d. Include information on correction of batching for varying moisture contents of fine aggregate.
        e. Submit source quality test records with mix design Submittal.
        f. Provide calculations demonstrating that the mixes proposed provide the required average compression strength of concrete (f'cr) based on source quality test records.
        g. For each Class A mix design submitted, plot the mix design Attachment B - Coarseness Factor Chart and submit.
        h. For each Class A mix design submitted, plot the combined aggregate gradation on the chart Attachment C - Combined Aggregate Gradation Chart and submit.

E. Concrete mixes - Trial batches:
    1. Drying shrinkage test results.
        a. Submit results of testing.
    2. Compression strength test results.
        a. Submit results of testing. Provide data for each cylinder tested.
        b. Submit data indicating trial batch mix designator, slump, and specimen number for each test cylinder.
    3. If there is any change in suppliers or in quality of concrete mix constituents, submit new test data.

F. Test reports:
    1. Dated not more than 24 months prior to the date of Submittal.
    2. Aggregate:
        a. Submit certified copies of commercial laboratory tests proposed for use in concrete.
        b. Sieve analyses:
            1) During construction, submit sieve analyses of coarse, intermediate, fine, and combined aggregates used any time there is a change in supplier, or a significant change in the character and/or grading of materials, and when requested by the Engineer.
        c. Aggregates - coarse:
            1) Physical properties:
                a) Sieve analysis.
                b) Percentage of particles having flat and/or elongated characteristics.
                c) Abrasion loss.
                d) Soundness.
            2) Deleterious substances:
                a) Clay lumps and friable particles content.
                b) Materials finer than No. 200 sieve (percentage).
                c) Shale and chert content.
                d) Coal and lignite content.
            3) Alkali reactivity.

d. Aggregates - Intermediate:
    1) Physical properties:
        a) Sieve analysis.
        b) Percentage of particles having flat and/or elongated characteristics.
        c) Abrasion loss.
        d) Soundness.
    2) Deleterious substances:
        a) Clay lumps and friable particles content.
        b) Chert and shale content.
        c) Coal and lignite content.
        d) Materials finer than No. 200 sieve.
    3) Alkali reactivity.
e. Aggregates - Fine:
    1) Physical properties:
        a) Sieve analysis and fineness modulus.
        b) Soundness.
    2) Deleterious substances:
        a) Clay lumps and friable particles (percentage).
        b) Materials finer than No. 200 sieve (percentage).
        c) Coal and lignite (percentage).
        d) Shale and chert.
        e) Organic impurities (“Color” as determined by ASTM C40).
    3) Alkali reactivity.
f. Aggregates - Combined:
    1) Test combined gradation for the following sieve sizes: 1.5 inches, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 100, No. 200.
    2) Bulk density in accordance with ASTM C29.
    3) Void content in accordance with ASTM C29.
    4) Submit at:
        a) Initial mixture design Submittal.
        b) Intervals of not more than 4 weeks.
        c) Any time there is a change in character or grading of constituent materials.
        d) When requested by the Engineer.

3. Cement:
    a. Mill tests, including alkali content measured as equivalent alkalis, for each shipment of cement included in the Work.
        1) During construction, submit mill certificates for cement being used at intervals of not more than 90 days, any time there is a change in supplier or a significant change in the character of the materials, and when requested by the Engineer.
4. Supplemental cementitious material:
    a. Fly ash: Identify source and provide testing results to demonstrate compliance with requirements of ASTM C618 and this Section.
        1) Include the Supplier’s report certifying the total alkali content of the material, expressed as equivalent percentage of sodium oxide (Na_2Oe).

G. Certificates:
   1. Current NRMCA certification for all plants and trucks that will be used to supply concrete.

H. Source Quality Control Submittals:
   1. Truck batch tickets for each load of concrete delivered to the site, whether accepted or rejected.
   2. Concrete supplier's quality control plan. Include the following elements, at a minimum:
      a. Names and qualifications of key quality control personnel:
         1) Quality control manager.
         2) Testing and inspection personnel.
      b. Names and qualifications of testing laboratories:
         1) Each laboratory shall hold current accreditation from the AASHTO Accreditation Program, or other accreditation program acceptable to the Engineer, for each test performed.
      c. Example forms for: Inspection reports, certificates of compliance, and test results.
      d. Quality control procedures: Method and frequency of performing each procedure, including inspections and materials testing. At a minimum, the plan shall include:
         1) Daily testing of aggregate gradation.
         2) Monthly testing of cement quality.
         3) Monthly testing of fly ash quality.
      e. Procedures to control quality characteristics, including standard procedures to address properties outside the specified operating limits, and example reports to document non-conformances and corrective actions taken. Include procedure for notifying the Contractor and Engineer of non-conformances.
      f. Procedures for verifying that:
         1) Materials are properly stored during concrete batching operations.
         2) Batch plants have the ability to maintain concrete consistency during periods of extreme heat and of low temperatures.
         3) Admixtures are dispensed in the correct dosages within the accuracy requirements specified.
         4) Delivery trucks have a valid NRMCA certification card.
      g. Procedures for verifying that weighmaster certificate for each load of concrete shows:
         1) Cement and supplementary materials are from sources designated in the approved Submittals.
         2) Concrete as-batched complies with the constituent weights designated in the approved Submittals.
         3) Corrections for aggregate moisture are being correctly applied.
         4) Any mix water withheld from the batch.
      h. Procedures for visually inspecting concrete during discharge.

I. Field Quality Control Submittals:
   1. Contractor's notifications of readiness for concrete placement.
   2. Contractor's reports of field quality control testing.
      a. Include with each report the concrete batch ticket number and identification numbers for associated cylinders used for compressive strength testing.

b. Testing results for slump, temperature, unit weight, and air entrainment.
c. Testing results for compressive strength at 7 and 28 days, and for any compressive strength tests after 28 days.
d. Note on batch ticket the amount of water that was withheld and the maximum amount that can be added on site as “Max add water.” Record on the batch ticket the volume of water actually added at site.
e. Note on the batch ticket the concrete mix classification as defined in Table 3 of this Section.

J. Special procedure Submittals:
1. Sequence of concrete placing:
a. Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements. Submittal shall include plans sections and details to address all pours.
2. Cold weather concreting plan.
3. Hot weather concreting plan.
4. Repair of defective concrete: Submit mix design for repair materials to be used.

1.06 QUALITY ASSURANCE

A. Pre-installation meetings:
1. Schedule and conduct pre-installation meeting at least 10 days prior to batching and placing of concrete.
a. Provide additional meetings if necessary, to discuss specific concrete Submittals, mixes, or placing and curing conditions.
b. Notify the Engineer of location and time of each conference.
2. Required attendees:
a. Contractor, including Contractor’s superintendent and key personnel.
b. Concrete supplier.
c. Technical representative(s) of supplier(s) of concrete admixtures.
d. Subcontractor(s) providing pumping, placing, finishing, and curing.
e. Subcontractor(s) providing embedded items (structural embedded plates, electrical conduit).
f. Sampling and testing personnel.
g. Engineer.
h. On-site inspectors representing the Engineer.
i. Other persons deemed by the Engineer and the Contractor to be critical to the quality and efficiency of the Work.
3. Agenda:
a. Review of requirements of Drawings and Specifications.
b. Project and product safety requirements.
c. Discussion of points of interface and coordination between various trades or products to be used in the Work.
d. Contractor’s schedule for cast-in-place concrete work.
e. Mix designs, mix tests, and Submittals.
f. Admixture types, dosing, performance, requirements for monitoring, and limits on dosing or re-dosing at the site.
g. Placement and consolidation methods, techniques, and equipment and the effects of those methods on form pressures.
h. Slump and limits on placing time or conditions to maintain placeability.
1) Field adjustment of slump and air content.

i. Procedures for finishing, curing, and retention of moisture during these operations.
j. Procedures and protection for hot and cold weather conditions.
k. Requirements and coordination for inspections.
1) Responsibility for test specimen curing and storage.
2) Distribution of test reports.
l. Other Specification requirements requiring coordination between parties to the Work.

4. Prepare and submit minutes of the pre-installation meeting as specified in Section 01312 - Project Meetings.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
1. Deliver, store, and handle concrete materials in a manner that prevents damage and inclusion of foreign substances.
2. Deliver and store packaged materials in original containers until ready for use.
3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at site:
1. Reject material containers or materials showing evidence of water or other damage.
2. Concrete mixes: Do not accept or incorporate into the Work concrete mixes that do not comply with the specified requirements for water content, slump, temperature, and air content.

1.08 PROJECT CONDITIONS

A. Cold weather concreting: During periods of cold weather as defined in this Section, implement cold weather concreting procedures in this Section.

B. Hot weather concreting: During periods of hot weather as defined in this Section, implement hot weather concreting procedures in this Section.

1.09 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in a manner that completes all placing operations from one construction, contraction, or expansion joint to another construction, contraction, or expansion joint.

B. Joints at each end of the placement shall be as indicated on the Drawings, or as identified and accepted in advance by the Engineer.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Provide concrete with a homogeneous mixture, that, when hardened, will have required strength, watertightness, and durability.

B. Provide a workable, low-shrinkage concrete mix that maximizes aggregate content and minimizes paste content.

C. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of Portland cement, supplemental cementitious materials, aggregate, admixtures and water, proportioned and mixed to produce a plastic, workable mixture in accordance with requirements of this Section, and suitable to specific conditions of placement.
      b. Proportion aggregates to produce an optimized gradation of aggregate that combines fine**,** intermediate, and coarse aggregate in well-graded proportions that maximizes the aggregate content and minimizes the paste content of the mix. Gradation should maximize long-term durability and strength of the concrete mixture.
      c. Durability requirements will be deemed to be satisfied when:
         1) Mixture is proportioned with a well-graded combined aggregate.
         2) Specified water-cement ratio is satisfied.
         3) Concrete contains the specified range of air content.
         4) Maximum specified paste content is satisfied.
      d. Proportion materials in a manner that will secure the lowest cement content, water-cementitious materials ratio, and paste volume that is consistent with good workability that provides a plastic and cohesive mixture, and that provides a slump that is within the specified range.
      e. Construction and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods have been specified, for purpose of to reduce the number and size of cracks, resulting from normal expansion and contraction expected from the concrete mixes specified.
      f. Remove and replace, or repair as specified in this Section, non-conforming work and surfaces with cracks, voids and honeycombs, or surface wetness.
   2. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI CODE-318, and ACI CODE-350.

2.02 MATERIALS - GENERAL

A. Water and ice:
   1. Water for concrete mixes, for washing aggregate, and for curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
   2. Do not use water from concrete production operations, or combined water from concrete production operations as defined in ASTM C1602.

2.03 MATERIALS - CONCRETE MIX CONSTITUENTS

A. Water and ice:
   1. As specified in the preceding paragraphs.

B. Cementitious materials:
   1. Portland cement:
      a. In accordance with ASTM C150.
         1) Type II
      b. Single source: To provide uniformity of appearance, for each structure use only one source, type, and brand of Portland cement for walls and slabs that will be exposed in the finished work.
         1) Confirm adequate supply of cement over duration of project before making trial batches or beginning concrete placements.
      c. Cement for finishing: Provide cement from the same source and of the same type as concrete to be finished or repaired.
      d. In accordance with NSF 61.
   2. Blended hydraulic cement:
      a. In accordance with ASTM C595:
         1) Type IP (MS).
         2) Type IL (MS).
      b. Single source: To provide uniformity of appearance and quality, for each structure use only 1 source, type, and brand of cement.
      c. Confirm adequate supply of cement over duration of project before making trial batches or beginning concrete placements.
      d. Cement for finishing: Provide cement from the same source and of same type as concrete to be finished or repaired.
      e. In accordance with NSF 61.

C. Supplementary cementitious materials:
   1. Fly ash:
      a. Class C or Class F fly ash in accordance with the requirements of ASTM C618, except as modified in this Section.
         1) Class C may be used in concrete made with Type II Portland cement.
         2) Class F required if used in concrete mixes containing aggregates classified as potentially reactive based on ASTM C1293 or ASTM C1260.
            a) CaO content: Less than 18 percent.
      b. Loss on ignition: Not exceeding 3 percent.
      c. In accordance with NSF 61.
      d. Replace Portland cement at ratio of 1.0 pound fly ash for each pound of cement, up to minimum and maximum replacement as specified in “Requirements for Mix Proportioning.”

D. Admixtures:
   1. General:
      a. Do not include admixtures, other than those specified, unless written acceptance has been obtained from the Engineer during Submittal of mix designs.

b. Compatible with concrete constituents and with other admixtures.
    1) All admixtures in a given mix shall be products of the same manufacturer to ensure compatibility.
    2) Manufacturers: One of the following or equal.
        a) Euclid Chemical.
        b) GCP Applied Technologies (formerly W.R. Grace).
        c) Master Builders Solutions/Sika.
        d) Sika Corp.
c. Do not use admixtures containing chlorides, calculated as chloride ion, in excess of 0.5 percent by weight of cement.
d. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
e. Admixtures used shall be the same products used in concrete trial batches, or the same products used in concrete represented by submitted field test records.

2. Air entraining admixture (AEA):
    a. In accordance with ASTM C260 and dosed to provide entrained air percentages specified in this Section.
    b. Provides entrained air as bubbles, evenly dispersed at the time of placement and during curing.
3. Water reducing admixture (WRA):
    a. May be used at the Contractor's option.
    b. Conforming to ASTM C494, Type A (water-reducing).
        1) ASTM C494, Type D (water-reducing and retarding) may be used during periods of hot weather with prior acceptance by the Engineer.
    c. Not containing air-entraining agents.
    d. Liquid form before adding to the concrete mix.
4. High-range water reducing admixtures ("super-plasticizers") (HRWR):
    a. Not permitted without acceptance by the Engineer.
5. Shrinkage reducing admixture (SRA):
    a. May be used at the Contractor's option.
        1) Provide shrinkage reducing admixture in sufficient dosage so as to produce shrinkage within the limits specified.
    b. Not containing expansive agents.
    c. In accordance with ASTM C494, Type S (specific performance).
    d. One of the following or equal:
        1) Euclid Chemical: Eucon SRA Series.
        2) GCP Applied Technologies: Eclipse Series.
        3) Master Builders Solutions/Sika: SRA Series.
6. Set-controlling admixtures:
    a. Shall not be used without prior acceptance from the Engineer.
    b. Accelerating admixtures: Not permitted.

E. Coloring admixtures:
    1. Conduit encasement coloring agent:
        a. Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
        b. Manufacturers: One of the following or equal:
            1) Davis Co., #100 Utility Red.
            2) Euclid Chemical Co., Increte Division, "Colorcrete Brick Red".
            3) I. Reiss Co., Inc., equivalent product.

c. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

F. Aggregate:
1. General:
a. Provide concrete aggregates that are sound, graded as specified, and free of deleterious material in excess of allowable amounts specified.
b. Provide aggregates to produce in-place concrete with unit weight as follows:
1) Normal weight concrete: Not less than 140 pounds per cubic foot.
c. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
d. Do not use aggregate recycled from fresh concrete returned to the batching facility.
2. Alkali-silica reactivity:
a. Provide aggregate classified as aggregate-reactivity class of R0 in accordance with ASTM C1778 with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260, and not greater than 0.04 percent at 1 year when tested in accordance with ASTM C1293.
3. Fine aggregate:
a. Material graded such that 95 to 100 percent of material passes the No. 4 (4.75 mm) sieve, when sampled in accordance with ASTM D75 and D3665, and tested in accordance with ASTM C136.
b. Provide fine aggregate consisting of clean, natural sand, or sand prepared from crushed stone or crushed gravel.
c. In accordance with ASTM C33 requirements for grading, deleterious substances, soundness, and alkali reactivity, except as modified in the following paragraphs:
1) Grading: For sieve sizes listed in ASTM C33 for fine aggregate, not more than 45 percent passing any sieve and retained on the next consecutive sieve.
2) Deleterious substances: Not in excess of the percentages by weight specified in Table 1 of this Section.

Table 1: Fine Aggregate, Limits on Deleterious Substances

Item	Test Method	Percent (maximum)
Materials finer than No. 200 sieve(2)	ASTM C117	3.00(2)
Clay lumps and friable particles	ASTM C142	1.00
Lightweight particles (SG < 2.40)	ASTM C123	1.00
• Chert or shale(1)	ASTM C295	1.00(1)
Coal and lignite	ASTM C123	0.50

Table 1: Fine Aggregate, Limits on Deleterious Substances		
Item	**Test Method**	**Percent (maximum)**

Notes:

(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage of lightweight particles (sum of shale, chert, coal and lignite) not greater than 1.00, testing under ASTM C295 will not be required.

(2) For manufactured sand, if material finer than the No. 200 sieve consists of crusher dust and the aggregate is essentially free of clay or shale, maximum percentage may be increased to 5.0 percent.

3) Organic impurities: Free of injurious amounts of organic matter and producing a supernatant liquid with color not darker than “standard color” when tested in accordance with ASTM C40.
4) Soundness: In accordance with requirements of ASTM C33 when tested in accordance with ASTM C88 using sodium sulfite solution.

4. Intermediate aggregate:
   a. Material graded such that 90 to 100 percent of material passes the 3/8-inch sieve, and not more than 5 percent of material passes the No. 50 (300 µm) sieve, when sampled in accordance with ASTM D75 and D3665 and tested in accordance with ASTM C136.
   b. Requirements for maximum percentage of impurities, abrasion loss, and soundness: As specified for coarse aggregate.
5. Coarse aggregate:
   a. Materials graded such that not more than 10 percent of material passes the 3/8-inch sieve, when sampled in accordance with ASTM D75 and D3665 and tested in accordance with ASTM C136.
   b. Consisting of gravel, crushed gravel, crushed stone, or a combination of these materials having clean, hard, durable particles free from calcareous coatings, organic matter, or other deleterious substances.
   c. Conforming to the requirements of ASTM C33, Class 4S for physical properties, deleterious substances, and alkali reactivity, except as modified in the following paragraphs:
      1) Grading:
         a) Size number as specified in ASTM C33, and as indicated in Table 3 of this Section, except as otherwise specified or accepted by the Engineer.
         b) Weights of flat or elongated particles (particles having a length greater than 3 times average width or thickness) not exceeding 15 percent when tested in accordance with ASTM D4791.
      2) Deleterious substances: Not in excess of the percentages by weight specified in Table 2 of this Section and having total of all deleterious substances exceeding 2 percent.

Table 2: Coarse Aggregate, Limits on Impurities		
Item	**Test Method**	**Percent (maximum)**
Clay lumps and friable particles	ASTM C142	0.50
Lightweight particles (SG < 2.40)	ASTM C123	1.25
• Chert or shale(1)	ASTM C295	1.00(1)
Materials finer than No. 200 sieve	ASTM C117	0.50(2)

Table 2: Coarse Aggregate, Limits on Impurities		
Item	**Test Method**	**Percent (maximum)**
Coal and lignite	ASTM C123	0.25

Notes:

(1) ASTM C123 tests for particles in the sample having a specific gravity less than 2.40. ASTM C295 is used to identify which of those lightweight particles are chert, shale, or coal and lignite. If testing under ASTM C123 indicates a combined percentage (sum of shale, chert, coal and lignite) not greater than 1.25, testing under ASTM C295 will not be required.

(2) When material finer than No. 200 sieve consists of crusher dust, maximum percentage may be increased to 1.00 percent. When mix design complies with provisions of ASTM C33, Table 4, footnote C, the maximum percentage may be increased in accordance with the equation in footnote C, up to a maximum of 1.5 percent.

3) Abrasion loss: Loss not greater than 45 percent after 500 revolutions when tested in accordance with ASTM C131.
4) Soundness: Loss not greater than 10 percent when tested in accordance with ASTM C88 using sodium sulfate solution.

2.04 MATERIALS FOR PLACING, CURING AND FINISHING

A. General:
   1. Materials shall be compatible with concrete and with other materials.
   2. Materials for placing, curing and finishing concrete that will be in contact with potable water:
      a. Non-toxic and shall not impart taste or odor to the water.

B. Cement grout:
   1. Use: For spreading over surface of construction and cold joints in concrete before placing additional concrete above those joints.
   2. As specified in Section 03600 - Grouting.

C. Concrete sealer:
   1. As specified in Section 03366 - Concrete Finishes.
   2. Not for use in water-containment structures.

D. Evaporation retardant:
   1. Tested and listed under NSF 61 for use direct contact with potable water.
   2. Use: For mitigating surface moisture evaporation from freshly placed concrete during rapid drying conditions. Placed after screeding.
   3. Waterborne, monomolecular, spray-applied compound, with fugitive dye to indicate coverage.
   4. Manufacturers: One of the following or equal:
      a. Euclid Chemical Co., Eucobar.
      b. Master Builders Solutions/Sika, MasterKure ER 50.

E. Nonslip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Abrasive Materials, Inc.

b. Exolon Co.
c. “Non-Slip Aggregate”, Euclid Chemical Co.

F. Plastic membrane for curing:
1. Polyethylene film: In accordance with ASTM C171.
2. Properties:
a. Color: White.
b. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
c. Loss of moisture: Not exceeding 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.

G. Sprayed membrane curing compound:
1. Tested and listed under NSF 61 for use direct contact with potable water.
2. Combination curing and sealing products (“cure and seal”) will not be permitted.
3. Properties:
a. Clear type with fugitive dye conforming with ASTM C309, Type 1D and containing no wax, paraffin, or oils.
b. For concrete placed or cured during hot weather, curing compound shall be as specified, except that:
1) It shall include a white, reflective fugitive dye.
2) Moisture loss during a 72-hour period shall not exceed 9 pounds per cubic yard when tested in accordance with ASTM C156.

H. Surface-applied sealing system:
1. Tested and listed under NSF 61 for use direct contact with potable water.
2. Manufacturers: One of the following or equal:
a. Euclid Chemical Co., Vandex Super.
b. Kryton International, Inc., Krystol T1.
c. Xypex Chemical Corp., Xypex Concentrate.
3. Where surface-applied sealing system is placed over concrete containing permeability reducing admixture for concrete exposed to hydrostatic conditions (PRAH), provide products of same manufacturer providing the admixture.

2.05 EQUIPMENT

A. General:
1. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material into mixers.

B. Batching equipment, or batch plant.
1. Capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.

C. Mixing equipment:
1. Mixers may be of stationary plant, paver, or truck mixer type, as appropriate to the Work.

2. Capable of combining aggregates, water, and cementitious materials, and admixtures within specified time into a thoroughly mixed and uniform mass, and of discharging the mixture without segregation.
    a. Maintain concrete mixing equipment in good working order, and operate at loads, speeds, and timing recommended by manufacturer or as specified.
    b. Proportion cementitious materials and aggregate by weight.
3. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
4. Prevent cementitious materials from encountering aggregate or water until materials are in mixer ready for complete mixing with all mixing water.
5. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to the Project Site, for final mixing and addition of mixing water will not be permitted.
6. Retempering of concrete will not be permitted.
7. Discharge the entire batch before recharging.
8. Volume of mixed material per batch: Not to exceed manufacturer's rated capacity of mixer.
9. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
10. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
    a. Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.
11. Transit-mixed concrete:
    a. Mix and deliver in accordance with ASTM C94.
    b. Total elapsed time between addition of water at batch plant and discharging completed mix.
    c. Not to exceed 90 minutes.
    d. Elapsed time at Project Site shall not exceed 30 minutes.
    e. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
    f. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
12. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until the drum has started revolving.
    b. The right is reserved to increase the required minimum number of revolutions or to decrease the designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such an increase or decrease.

D. Other types of mixers: For other types of mixers, mixing shall be as follows:
    1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
    2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.

3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.06 CONCRETE MIXES

A. General:
   1. Develop and provide mix designs for each concrete class listed in Table 3 of this Section.
   2. Select and proportion mixes and document properties using one of the 2 methods that follow. Procedures and requirements for use of each alternative are specified in subsequent paragraphs of this Section.
      a. Field experience method.
      b. Trial batch method.
   3. Organize and submit mix designs with data on all constituent materials and products for that mix for the Engineer's review.
   4. Do not place concrete until the mix design for that concrete class has been accepted by the Engineer.
   5. After acceptance, do not modify accepted mixes or provide new mixes without the Engineer's prior review and acceptance of the proposed alternative.
      a. Exception: At all times, adjust batching of water to compensate for free moisture content of the fine aggregate used.
      b. For any change to approved mixes, the Engineer may require new trial batching and testing program as specified in this Section before acceptance and use.
      c. For any change to approved mixes, make modifications within limits set forth in this Section.
      d. If there is change in source or quality of any constituent of the concrete class or mix, the revised mix will be considered a new class of concrete and shall require full re-submittal of all data describing mix constituents, design, and testing.
   6. Material sampling, mix designs, trial batch preparation and testing, modifications to mix designs, and any re-testing required to satisfy the requirements of this Section or to obtain satisfactory performance shall be at the Contractor's expense and shall not be considered cause for delay.

B. Measurements of materials:
   1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
   2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
   3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
   4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
   5. Weighing cementitious materials:
      a. Weigh cementitious materials separately.
      b. Cement in unbroken standard packages (sacks): Need not be weighed.
      c. Weigh bulk cementitious materials and fractional packages.
   6. Measure mixing water by volume or by weight.

C. Requirements for mix proportioning:
    1. Develop and provide mixes that:
        a. Can be readily worked into corners and angles of forms and around reinforcement, without excessive vibration, and without permitting materials to segregate or free water to collect on surface.
        b. Prevent unnecessary or haphazard changes in the consistency of the concrete supplied.
    2. Constituent materials:
        a. Provide concrete mixes composed of Portland cement or blended cement, blended aggregates, admixtures and water.
            1) Admixtures required for each concrete class are indicated in Table 3 of this Section. Admixtures not specifically required by that table for a specific concrete class are optional and may be included at the discretion of the Contractor based on the Contractor's planned means and methods of construction.
        b. In no case shall returned fresh concrete or its constituents be incorporated into concrete batched for the Work.
    3. Minimum specified compressive strength:
        a. Minimum specified compressive strength is designated at 28 days, unless otherwise indicated in Table 3 of this Section.
        b. For locations where the placed concrete is adequately protected and is not subjected to loads for an extended period during construction, the Contractor may request that the period for achieving the minimum specified compressive strength be extended to 56 days. If accepted by the Engineer, provide mixes that achieve at least 75 percent of their minimum specified compressive strength after 28 days.
    4. Proportions and consistency:
        a. Ratio of water to cementitious materials, and cementitious materials content:
            1) Conform to maximum and minimum cementitious material content requirements specified in Table 3 of this Section.
            2) Cementitious materials content: Consisting of Portland cement or blended cement as indicated in Table 3 of this Section, plus supplemental cementitious materials if aggregate testing indicates potentially reactive aggregates:
                a) Fly ash content:
                    (1) Minimum: 15 percent of the total weight of cementitious materials.
                    (2) Maximum: 25 percent of the total weight of cementitious materials.
                    (3) Class M: Provide 20 to 25 percent by weight of the total cementitious content as Class F fly ash.
        b. Aggregate size and content:
            1) Blend aggregates to produce an optimized gradation that combines well-graded coarse, intermediate, and fine aggregates in proportions that maximize the aggregate content of the mix, and that minimize the cement paste content of the mix.
                a) Percentage of individual fractions of the combined aggregate gradation retained on individual sieve sizes: Within the range shown in Attachment C - Combined Aggregate Gradation Chart ("Tarantula Curve").

b) Sum of the percentages of individual fractions retained on the No. 8, No. 16, and No. 30 sieves: Greater than 20 percent.
c) Sum of the percentages of individual fractions retained on the No. 30, No. 50, No. 100, and No. 200 sieves: Within the range of 25 percent to 40 percent.

c. Determine bulk density and void content of the combined gradation of aggregates in accordance with ASTM C29. Results for combined aggregates shall not be the summation of results of testing of the individual gradations.
1) Sample the combined aggregate from a flowing aggregate stream or conveyor in accordance with ASTM D75. Take care to ensure that the sample is representative of the proportions of the combined aggregate of the proposed mix.
2) Reduce sample of combined aggregate to test sample size in accordance with ASTM C702, Method A - mechanical splitter or Method B - quartering.
3) Perform bulk density test of combined aggregate in accordance with ASTM C29, Procedure A - rodding.
4) Determine void content of the combined aggregate in accordance with ASTM C29, Procedure A - rodding. Specific gravity of the combined aggregate shall be determined in accordance with ASTM C136.

d. Paste content: Limited to the following:
1) Class A mixes without air entrainment: Maximum 28 percent measured by volume.
2) Class A mixes with air entrainment: Maximum 28 percent measured by volume plus the target air content.
3) Paste content shall be limited to 175 percent of the void content of the combined aggregate gradation determined by ASTM C29.

e. Total water content:
1) Not exceeding the water to cementitious material ratio specified in Table 3 of this Section.

f. Coarseness/workability (Shilstone Method):
1) Proportion mixes to fall into the “Optimal” zone (Zone II) when plotted on the Coarseness Factor Chart (“Coarseness Factor” versus “Workability Factor”) included as Attachment B - Coarseness Factor Chart to this Section. Provide plot for each Class A mix to be used in the Work.
2) Coarseness factor (CF) for each mix shall be calculated as the percent of the combined aggregate gradation retained on the 3/8-inch sieve, divided by the percent of the combined aggregate gradation retained on the No. 8 sieve, multiplied by 100, or:

$$CF = \frac{(\%\ \text{retained on 3/8 in sieve})}{(\%\ \text{retained on No. 8 sieve})} \times 100$$

3) Workability factor (WF) for each mix shall be the percent of the combined aggregate gradation retained on the No. 8 sieve, adjusted for cement content in the mix.
a) Determine volume of total cementitious material in the mix.
b) For each 94 pounds of cement content above 564 pounds per cubic yard, increase workability factor by 2.5 units.

c) For each 94 pounds of cement below 564 pounds per cubic yard, decrease workability factor by 2.5 units.
d) Proportion adjustment factor by linear interpolation for each fraction of 94 pounds above or below the 564 pound basis.
e) Example:
650 pounds per cubic yard = 564 pounds + 86 pounds.
Adjustment = (86 lb / 94 lb) x 2.5 = + 2.28.

D. Concrete classes for use in the Work:
1. Provide concrete classes listed in Table 3 of this Section.
2. Provide normal weight concrete, having minimum weight of 140 pounds per cubic foot, unless otherwise noted.
3. Pumped concrete:
a. Provide pumped concrete that complies with all requirements of this Section.
b. Mixes placed by pumping shall be considered a sub-class of each concrete class listed in Table 3 of this Section. Prepare and submit a separate mix design for each mix to be placed by pumping.
4. Class PM concrete: In addition to the requirements of Table 3 of this Section, conform to the following:
a. Minimum 28 day flexural strength: 650 psi when tested in accordance with ASTM C293.
b. Cementitious materials content: 75 percent Portland cement plus 25 percent Class F fly ash (by weight), blended cement conforming to Type IP(25), or 75 percent Type IL blended cement plus 25 percent Class F fly ash (by weight).
c. Aggregate:
1) Minimum 55 percent coarse aggregate conforming to ASTM C33 size number 357 or size number 467.
2) Substitute ASTM C33 size number 57, or size number 67 if mechanical paving equipment is not used.
5. Class M concrete: In addition to the requirements of Table 3 of this Section, conform to the requirements for Class A concrete.

Table 3: Concrete Classes									
Concrete Class[1]	**Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)**	**Ratio of water to cementitious materials[3] (minimum - maximum).**	**Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]**	**Cement Type**	**Maximum Chloride Content (percent by weight of cement)**	**Maximum Size of Coarse Aggregate (ASTM C33)**	**Air Entrainment (percent), (n/a: not applicable)**	**Admixtures required[4,5,6]**	**Slump Range (inches)**
A	4,500	0.40 to 0.42	535 to 575	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS) or IP(20)(MS)	0.10	#57	6±1.5	AEA WRA	2 to 4
C	2,500	0.62 max.	423 min.	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS) or IP(20)(MS)	No limit	#57	6±1.5	AEA WRA	3 to 6
CE	3,000	0.62 max.	423 min.	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS) or IP(20)(MS)	No limit	#8	5±1.5	AEA WRA	3 to 6
PM	5,000	0.40	535 to 575	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS) or IP(20)(MS)	0.15	#57	6±1.5	AEA WRA	3 to 6
M	4,500	0.40 to 0.42	535 to 575	ASTM C150, Type II(MH) or ASTM C595, Type IL(<15)(MS) or IP(25)(MS)	0.10	#4	6±1.5	AEA WRA	2 to 4

Notes:

(1) Sub classes within major concrete classes are designated as follows:
NA: Without air entrainment.

(2) At locations where concrete will not be subjected to load from other elements of the structure or from the Contractor's placing and/or backfilling operations, maximum time period for achievement of specified compressive strength may be extended to 56 days when accepted by the Engineer.

Table 3: Concrete Classes									
Concrete Class[1]	**Minimum Specified Compressive Strength at 28 days, f'c [2] (pounds per square inch)**	**Ratio of water to cementitious materials[3] (minimum - maximum).**	**Cementitious Materials Content (pounds per cubic yard of concrete by weight)[4]**	**Cement Type**	**Maximum Chloride Content (percent by weight of cement)**	**Maximum Size of Coarse Aggregate (ASTM C33)**	**Air Entrainment (percent), (n/a: not applicable)**	**Admixtures required[4,5,6]**	**Slump Range (inches)**

(3) W/C Ratio = Ratio of water to cementitious materials by weight. Include weight of admixtures in the water content of the mix when the quantity of the admixtures exceeds 10 ounces per 100 pounds of cement.

(4) Cementitious material includes Portland cement plus supplemental cementitious materials. If trial batch testing demonstrates that the required strength cannot be met at 28 or 56 days with the specified combined aggregate gradation and the paste content limits, cementitious material content may be increased with the Engineer's approval if Class M concrete is provided and Thermal Control Plan and Temperature Monitoring Program in accordance with Section 03703 - Thermal Control of Concrete is provided for cast-in-place concrete elements. Cement content and/or threshold for the thermal control requirement may be adjusted by the Engineer based on the Equivalent Cement Content (ECC) of the approved Class M concrete mix.

(5) Admixtures are designated as follows:
AEA: Air entraining admixture.
HRWR: High-range water-reducing admixture.
PRAH: Permeability-reducing admixture for concrete exposed to hydrostatic conditions.
SFR: Synthetic fiber reinforcement.
SRA: Shrinkage-reducing admixture.
WRA: Water-reducing admixture.

(6) At the Contractor's option, each concrete class may include a high-range water reducing admixture (HRWR). Designate such mixes as the "class" specified followed by "SP" (e.g., A-SP, PM-SP, etc.). Submit as separate mixes for review. Slump range after addition of HRWR: 4 to 6 inches.

E. Install concrete classes in accordance with the following requirements, unless otherwise indicated on the Drawings.
   1. Class A concrete: Structural concrete.
      a. Use at all locations unless other Classes are specified or indicated on the Drawings.
   2. Class A-NA concrete: Structural concrete without air entrainment.
      a. May be used in lieu of Class A at indoor slabs (not subject to freezing and thawing) where inclusion of an air-entraining admixture makes it difficult to achieve the specified concrete finish.
   3. Class C concrete: Miscellaneous concrete fill and encasement.
      a. May be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   4. Class CE concrete: Use for electrical conduit encasements.

5. Class PM concrete: Use for concrete pavement, cart paths, curbs, gutters, and sidewalks.
6. Class M concrete: Use at placements when the minimum dimension exceeds 36 inches or when the maximum specified cementitious material exceeds the limit in Table 3 and the minimum dimension exceeds 24 inches.

F. Concrete mix design documented by field experience:
   1. Mix design:
      a. Prepare preliminary mix design for each concrete class. Submit mix design with product and testing data for materials to be used in the mix for the Engineer's review.
   2. Historical records for similar mix.
      a. Determinations of similarity of materials and proportions between historical and proposed mixes shall be by the Engineer, and that shall be final.
      b. Historical record - Materials:
         1) Submit with each mix design the following data for a previously supplied concrete mix similar to that proposed for this Work.
         2) Records demonstrating that the previously supplied mix included similar materials and proportions as those of the proposed mix.
            a) Documentation that the same concrete supplier will provide both mixes.
            b) Documentation that the materials used was from the same suppliers and had essentially the same properties, demonstrated by test data, as those proposed.
            c) Documentation that proportions of materials in the record mix are essentially the same as those proposed and that the specified compressive strength of the record mix is within 1,000 pounds per square inch of that required by this Section.
            d) Concrete supplier's statement describing any changes made to production of the record mix during the time period reported.
            e) Concrete supplier's statement that preparation and quality control procedures for the record mix were essentially the same as those to be employed for this Work.
      c. Historical record - Testing:
         1) Submit with each record mix, corresponding test data for slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
         2) Only records satisfying the following requirements will be accepted.
            a) All tests were conducted within a period of 1 year preceding the date of the Submittal.
            b) All tests were conducted over a period including not less than 45 days.
            c) Record of compressive strength testing includes at least 30 tests for slump and 28-day compressive strength.
            d) Record of compressive strength tests is consecutive. In other words, it includes all tests conducted on the subject mix within the 1-year time period described above (not just selected tests during that period).
            e) Submit concrete supplier's sworn statement confirming that all tests for the record mix have been reported.

f) Tests for drying shrinkage are described in subsequent paragraphs of this Section for “concrete mix design documented by trial batch preparation and testing”.
g) Provide supplementary testing if requested by the Engineer.

d. For mixes determined to be similar and to have an acceptable test history, acceptance criteria shall be as follows:
1) Acceptance criteria:
a) Slump: All tests within limits specified for record mix.
b) Compressive strength: Average compression strength for tests, as determined by ACI CODE-350 not less than minimum required average strength.
c) Drying shrinkage: Within limits stated in subsequent paragraphs of this Section for “concrete mix design documented by trial batch preparation and testing”.

G. Concrete mix design documented by trial batch preparation and testing:
1. Mix design and trial batches:
a. Prepare preliminary mix design for each concrete class. Submit mix design with product and testing data for each combination of materials and proportions to be used for the Engineer’s review.
1) Determine water content of the mix based on curves showing the relation between water-cementitious materials ratio and the 7- and 28-day compressive strength of the concrete.
2) Determine each curve using 4 or more points, each representing the average compressive strength value of at least 3 specimens tested at each age.
b. After materials and proposed mix designs have been accepted by the Engineer, have trial batches for each concrete mix design prepared by the Contractor’s testing laboratory.
1) Prepare trial batches using the cementitious materials, aggregates, and admixtures proposed to be used for the Work.
2) Provide batches of sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient specimens for testing.
c. For each trial batch, make and test specimens to determine and report slump, compressive strength (with relationships for rate of strength gain between testing ages), and drying shrinkage.
1) If trial batches do not produce concrete conforming to the specified requirements for slump, strength, workability, consistency, drying shrinkage, restrained shrinkage, and finishing, change mix proportions and, if necessary, sources of materials.
2) Make additional trial batches and perform additional tests until a batch that conforms to requirements of this Section is produced.
2. Testing - Slump:
a. Determine slump in accordance with ASTM C143.
b. Acceptance criterion: Slump within range specified.
3. Testing - Compressive strength:
a. Prepare 4-inch diameter by 8-inch long cylinders in accordance with ASTM C31 for tests specified in this Section.

b. Determine average compressive strength:
    1) Test at least 12 cylinders from each trial batch for compressive strength in accordance with ASTM C39.
    2) Test 4 cylinders at 7 days, another 4 at 28 days, and another 4 at 56 days.
    3) Calculate average compression strength for 7 day tests, for 28 day tests, and for 56 day tests.
    4) Calculate ratios for:
        a) Average 7 day strength to average 28 day strength.
        b) Average 28 day strength to average 56 day strength.

c. Determine the required average compressive strength for each mix, f'cr, as described in the following paragraphs:
    1) Calculate required average compressive strength (f'cr) based on the minimum specified 28-day compressive strength, f'c, plus a standard deviation determined from the test history available for that mix.
    2) Determine f'cr as specified in ACI CODE-350, except as modified in the following paragraphs:
        a) Where 15 or more 28-day compressive strength tests are available, calculate standard deviation as described in the preceding paragraphs for "concrete mix design documented by field experience". Add this standard deviation to the specified minimum compressive strength to determine the required average compressive strength (f'cr) for the mix.
        b) Where fewer than 15 compressive strength tests at 28 days are available, determine minimum required compressive strength, (f'cr) from Table 4 of this Section.

Table 4: Required Average Compressive Strength, Fewer than 15 Tests Available

Minimum Specified Compressive Strength, f'c (pounds per square inch)	Required Average Compressive Strength, f'cr (pounds per square inch)
Less than 3,000	f'c + 1,000
3,000 to 5,000	f'c + 1,200
Over 5,000	f'c + 1,400

d. Acceptance criterion: Average compressive strength of the 4 cylinders tested at 28 days, or of the 4 cylinders tested at 56 days when permitted by the Engineer, shall equal or exceed the required average compression strength, f'cr for that concrete mix design.

4. Testing - Chloride content:
    a. Submit test results showing that the concrete mix contains water-soluble chloride ion content contributed from the constituents including water, aggregates, cementitious materials, and admixtures is less than the limit specified in Table 3 of this Section. Test shall be performed in accordance with ASTM C1218 at age between 28 and 42 days.
5. Testing - Drying shrinkage - Prism specimens:
    a. Class A (including A, A-SP), Class M, and Class PM: From trial batch for each mix, prepare 10 drying shrinkage specimens in accordance with ASTM C157 Divide specimens into 2 groups of 5 specimens each:

1 group including shrinkage-reducing admixture, and 1 group without shrinkage-reducing admixture.

b. Prepare, cure, and test both groups in accordance with ASTM C157, except as modified in the following paragraphs.
    1) Remove drying shrinkage specimens from molds at age of 23 hours, plus or minus 1 hour, after trial batching.
        a) Immediately place them in lime-saturated water maintained at 73 degrees Fahrenheit, plus or minus 3 degrees, for at least 30 minutes.
        b) Remove specimens from the water and wipe with a damp cloth.
        c) Measure to nearest 0.0001 inch to determine original length.
        d) Record measurements and re-submerge specimens in lime-saturated water at 73 degrees Fahrenheit, plus or minus 3 degrees, for moist curing.
    2) Maintain submerged curing conditions at 73 degrees Fahrenheit, plus or minus 3 degrees, for 7 days. 7 days after batching, remove specimens from water and repeat measuring procedures.
    3) Immediately store specimens in a humidity controlled room maintained at 73 degrees Fahrenheit, plus or minus 3 degrees, and at 50 percent relative humidity plus or minus 4 percent for remainder of the test.
    4) At periods of 14, 21, 28, and 56 days after batching, remove specimens from curing room and repeat measurements.

c. Drying shrinkage test report:
    1) Report measurements of all specimens at 1, 7, 14, 21, 28, and 56 days after batching.
    2) Using measured length at 7 days as base length for drying shrinkage, calculate the following for each measuring period:
        a) Drying shrinkage of each specimen. Determine as difference between the 7-day base length and measured length for each period.
        b) Average of these differences. If drying shrinkage of any specimen departs from the average of the measurements for each period by more than 0.0004 inch, disregard results obtained from that specimen.
        c) Percentage of drying shrinkage from batching to date of measurement.

d. Drying shrinkage acceptance criteria:
    1) Average shrinkage of trial batch concrete specimen group at 28 days after batching, when measured and cured as indicated, shall not exceed 0.035 percent.

e. Mixes accepted by the Engineer:
    1) Retain drying shrinkage test specimens. Bag in re-sealable plastic bags and submit to the Engineer.
    2) Indicate trial batch identifier, specimen number, and date of final measurements on each specimen bag.

2.07 SOURCE QUALITY CONTROL

A. Sample and test materials in accordance with the following requirements:
   1. Sampling, testing, and reporting frequency:
      a. In preparation for mix design submittals and trial batch tests.
      b. Whenever there is a change in source of the material, or a significant change in the characteristics or quality of materials from the same source.
      c. For each 10,000 cubic yards of concrete mix produced.
      d. At intervals not exceeding 90 calendar days, unless otherwise specified in the following paragraphs.
   2. Supplemental cementitious materials.
      a. Sample and test fly ash in accordance with ASTM C311.
   3. Aggregate:
      a. Sample combined aggregate in accordance with ASTM D75 and D3665, and test for gradation in accordance with ASTM C136.
      b. At least once every 30 days, and when requested by the Engineer.
      c. Submit test results.
   4. Cementitious materials:
      a. Sample and test cementitious materials and provide mill certificates demonstrating compliance with ASTM C150 or ASTM C595, and additional requirements of this Section.
         1) Determine alkali content by method set forth in ASTM C114.
      b. At least once every 90 days, and when requested by the Engineer.
      c. Submit test results.

B. Batch materials in accordance with the following requirements:
   1. Concrete batch weights: Control and adjust so as to secure maximum yield, and at all times maintain proportions of concrete mix within specified limits.
   2. Aggregates:
      a. Obtain aggregate from a source capable of providing uniform quality, moisture content, and grading during any single day's operation.
      b. Furnish satisfactory means at batching plant for checking moisture content of fine aggregate for each batch.
   3. Admixtures:
      a. Batch solutions using mechanical batcher capable of accurate measurement.
      b. Air entraining admixture: Add to batch in portion of the mixing water, unless otherwise recommended by the admixture manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare and submit mix designs for each concrete class indicated in Table 3 of this Section.

B. Submit proposed sequence of concrete placements. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested by the Contractor and accepted by the Engineer.
   1. Use construction methods and sequence work to allow concrete placement to reach adequate strength and to be constructed with required support to prevent overstress of the concrete structure during construction.

C. Make provisions for monitoring weather conditions:
   1. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
   2. Monitor the weather forecast beginning at least 48 hours prior to any concrete placement and make provisions for cold weather concreting or hot weather concreting if those conditions exist or are forecast to exist during the period of placement, finishing, and curing.
      a. Record temperature, relative humidity, and wind speeds for each placement beginning at least 24 hours before scheduled delivery of concrete.

D. Place no concrete without the Engineer's prior acceptance of conditions.

E. Notify the Engineer in writing that preparations are complete and ready for placement of concrete. Such notification shall indicate readiness - not just intention - to place concrete for the designated portion of the Work.
   1. Submit notification to the Engineer on forms provided by or acceptable to the Engineer and bearing the signature of the Contractor's superintendent.
      a. Sample form is included at the end of this Section, see Attachment B - Coarseness Factor Chart.
   2. Submittal of notification will be the Contractor's certification that preparations are complete and in accordance with the Contract Drawings and Specifications.
   3. Provide notification for the Engineer to make final observations at the locations of concrete placements not less than 24 hours before commencing placement of concrete.

3.02 CONCRETE JOINTS

A. Locations of joints are indicated on the Drawings.
   1. In order to preserve strength and watertightness of structures, make no other joints, except as authorized by the Engineer.
   2. Construct joints where indicated, and as indicated on the Drawings.
   3. Where joint locations are not indicated on the Drawings, submit the Contractor's proposed locations for the Engineer's review and acceptance. Provide construction joints in slabs and walls at intervals not greater than 35 feet.

B. Time between placements of adjacent concrete separated by joints.
   1. Provide not less than 7 days (168 hours) between placement of adjacent sections for the following:
      a. Slabs.
      b. Walls.

2. Provide not less than 14 days (336 hours) between placement of the lower and upper pours for the following:
    a. Walls over slabs.
    b. Slabs over walls.
    c. Slabs keyed into the sides of walls.

C. Edges of joints:
    1. Provide joints have edges detailed as indicated on the Drawings.
    2. Protect wall and slab surfaces at edges from concrete splatter. Thoroughly clean adjacent surfaces after completion of each placement.

D. Joint construction:
    1. Preparation of forms:
        a. Provide cleanout holes at base of each wall and column for inspection and cleaning.
        b. Wash forms and adjacent joint surfaces of sawdust, chips, and other debris after forms are built, and immediately before concrete or grout placement.
        c. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use a vacuum cleaner for their removal and then flush cleaned surfaces with water.
    2. Before placing concrete against previously placed concrete, thoroughly clean the prior placement of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of pressure washing.
    3. Provide and install waterstops, expansion joint material, and other similar materials as indicated on the Drawings and as specified.
        a. Take special care to ensure that waterstops are secured in proper position.
        b. Take special care to ensure that concrete is well consolidated around and against waterstops during placement.
    4. Horizontal joints:
        a. As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03600 - Grouting.
            1) Thickness: Not less than 1/2 inch or more than 1 inch.
        b. For wall placements above planned cold joints, placement of cement grout will not be required for locations where the wall mix includes high-range water-reducing admixture (“superplasticizers”), and the Contractor can demonstrate dense concrete joints without voids or honeycomb after the forms are removed.

3.03 MEASURING AND BATCHING MATERIALS

A. Measurements of materials:
    1. Proportion and measure cementitious materials and aggregates by weight.
        a. Weigh cementitious materials separately.
        b. If bulk cementitious materials are used, weigh them on separate visible scale that will accurately register scale load at any stage of weighing operation from zero to full capacity.
        c. Cement in unbroken standard packages (sacks) need not be weighed.
    2. Mixing water: Measure by volume or by weight.
    3. Other mix constituents: Measure by weight, except as otherwise specified or accepted by the Engineer.

4. Weighing and measuring devices:
    a. Use equipment designed and constructed specifically for that purpose.
    b. Furnish devices capable of weighing successive quantities of individual material measured to within 1 percent of desired weight of that material.
    c. Bearing valid seal of the department of weights and measures for the authority having jurisdiction over the Work.
5. Measurements and measuring devices:
    a. Subject to review by the Engineer.

B. Batching:
1. Admixtures shall be added at the concrete batch plant.
2. Addition of admixtures in the field is permitted only with prior acceptance by the Engineer, and only when the following conditions are satisfied:
    a. Dosage and mixing is personally overseen by concrete supplier's trained technologist.
    b. Adequate mixing is provided after addition.
    c. Maximum time to placement of concrete remains 90 minutes after water added to mix - not 90 minutes after any field additions/adjustments.
    d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.

3.04 MIXING AND TRANSPORTING

A. Machine mixing:
1. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer and ready for complete mixing with all mixing water.
2. Procedure of mixing cementitious materials with sand, or with sand and coarse aggregate, for delivery to the Project Site for final mixing and addition of mixing water is not permitted.
3. Remixing of concrete that has started to take its initial set ("retempering") is not permitted.
4. Discharge entire batch before recharging.
5. Volume of mixed material per batch: Not exceeding manufacturer's rated capacity of mixer.

B. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C94, except as modified in this Section.
2. Total elapsed time between addition of water at batch plant and discharging completed mix:
    a. Not to exceed 90 minutes or 300 revolutions of the mixing drum.
    b. Under conditions contributing to rapid setting, total elapsed time permitted may be reduced by the Engineer.
3. Temperature - minimum and maximum allowable during mixing and transporting:
    a. Minimum: 50 degrees Fahrenheit.
    b. Maximum: 90 degrees Fahrenheit.
4. Continuously revolve drum after it is started until it has completely discharged its batch.
    a. Do not add water until drum has started revolving.

b. Engineer reserves the right to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. Contractor will not be entitled to additional compensation because of such increase or decrease.

C. Concrete delivery:
   1. Furnish to the Engineer a delivery ticket for each batch of ready mixed concrete within 24 hours after delivery. Include the following information on each ticket:
      a. Time of day concrete was batched, and time of day that discharge from the truck is complete.
      b. Printed record of the individual weight of each of the following constituents in the batch: Fine aggregate, coarse aggregate, cement, pozzolan, and water.
      c. Concrete class as defined in Table 3 of this Section.
      d. Type, brand, and quantity of each admixture in the batch.
      e. Total volume of water allowed in the mix, volume of mixing water added at the batch plant, volume of mixing water withheld from the mix during batching, and total volume of any water added to the mix after leaving the batch plant.
         1) In no case shall volume of mixing water withheld result in a water/cementitious materials ratio less than the minimum values specified in Table 3 of this Section.
      f. Number of revolutions of transit truck at arrival on site, and total number of revolutions when discharge is complete.
      g. Volume of concrete delivered in the batch.
      h. Numerical sequence of the batch delivered for that placement.
   2. Additional water may only be added to the mix when the following conditions are fully satisfied:
      a. Batch ticket showing total volume of water already added and maximum volume of water that may be added is available for the Engineer's observation before any additional water is added.
      b. Total volume of water in the mix after the addition will be less than the maximum allowable volume of water indicated on the ticket.
      c. Full concrete load is still within the truck's mixing drum, and truck has not begun to discharge the load. Under no conditions shall water be added in the field to a partial truckload of concrete.
      d. Volume of water added, and time of addition are clearly marked for record on the batch ticket delivered to the Engineer.
   3. Addition of admixtures in the field is permitted only with prior approval by the Engineer, and when the following conditions are satisfied:
      a. Dosage and mixing is personally overseen by the concrete supplier's trained technologist and the admixtures supplier's representative.
      b. Adequate mixing time is provided after addition of admixtures.
      c. Maximum time to placement of concrete remains 90 minutes after water is added to the mix - not 90 minutes after any field additions/adjustments.
      d. Slump at discharge after additions/modifications conforms to the requirements of Table 3 of this Section.

D. Conveying concrete:
   1. Convey concrete from mixer to location of final deposit by methods that prevent separation or loss of materials.
   2. Use equipment for chutes, pumps, and conveying of concrete of such size and design as to ensure practically continuous flow of concrete, from delivery to the point of placement, without separation of materials.
   3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
   4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

3.05 PLACING AND CONSOLIDATING

A. Preparation:
   1. Obtain the Engineer's acceptance of completed preparations before placing concrete.
      a. Notify the Engineer in writing that all preparations are complete and ready for placement of concrete. Such indication shall indicate readiness, not just intention, to place concrete for the designated portion of the Work.
      b. Submit completed Attachment D - Contractor's Concrete Placement Checklist Form.
   2. Confirm completeness of the following before notification of readiness is given to the Engineer:
      a. Place forms, reinforcement, screeds, anchors, ties, and inserts in final position.
      b. Reinforcement is secure and properly fastened in its correct position.
      c. Loose form ties at construction joints have been retightened.
      d. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
      e. Forms have been cleaned of debris and form release agents are applied as specified.
   3. Preparation for placement of footings and slabs on grade:
      a. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
      b. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
      c. If subgrade surface becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
      d. Do not place concrete if subgrade is muddy or soft.
   4. Keep sufficient protective coverings on hand at all times for protection of concrete during and after placement.
      a. Protect concrete placed before rain to prevent water from coming in contact with such concrete.
      b. Protect concrete placed before winds to prevent excessive drying or embedment of debris in the finished surfaces.

B. Concrete placement:
   1. Do not place concrete:
      a. With slump outside the limits specified in Table 3 of this Section.
      b. In which initial set has occurred, or that has been retempered.
      c. During rainstorms or high velocity winds.
   2. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
      a. Do not deposit concrete in large quantities in one place, and then work material along forms with vibrator or by other methods.
   3. Do not drop concrete freely into place from height greater than 5 feet. Use tremies for placing concrete where drop is over 5 feet.
   4. Place concrete on slopes starting from bottom of slope and working upward.
   5. Place concrete in horizontal lifts not exceeding 24 inches in depth and bring up evenly in all parts of forms.
   6. After concrete placement begins, continue in a continuous operation without significant interruption until the end of the placement. Plan and implement precautions to prevent any delay, between layers or adjacent volumes, from exceeding 20 minutes.
   7. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout over surface before placing additional concrete. Provide grout layer thickness of not less than 1/2 inch or more than 1 inch.
   8. Placement of concrete for slabs, beams, or walkways:
      a. If cast monolithically over walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
      b. Allow set time of not less than 1 hour for shrinkage.
         1) During waiting time, keep top surface of concrete moist, but not wet.
         2) Do not permit water to pond or stand on the surface.
         3) Do not coat surface with evaporation retarders or curing agents.
      c. Start placement above wall or column with layer of cement grout as described in the preceding paragraph.

C. Consolidating concrete:
   1. Consolidate concrete with aid of acceptable mechanical vibrators.
   2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the Work.
   3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
   4. Vibrators:
      a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
      b. In addition to vibrators in actual use while concrete is being placed, have on hand a minimum of 1 spare vibrator in operable condition.
      c. Do not place concrete until it has been confirmed that all vibrating equipment, including spares, are in operable condition.
   5. Place concrete solidly against forms and concrete surfaces, leaving no voids or honeycomb.
   6. Make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.
   7. Do not over-vibrate so as to produce segregation.

3.06 FINISHING CONCRETE

A. Provide concrete finishes in accordance with Section 03366 - Concrete Finishes, unless otherwise indicated on the Drawings.

B. Liquid evaporation retardant:
   1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, coat the surface of the concrete with a liquid evaporation retardant immediately after screeding.
   2. Conditions that result in rapid evaporation of moisture are defined as any combination of ambient temperature, concrete temperature, relative humidity, wind speed, and solar radiation intensity that creates conditions that will evaporate water from a free concrete surface at a rate equal to or greater than 0.1 pounds per square foot per hour as determined by the Menzel Formula and nomograph published in ACI PRC-305 and included as Attachment A - Menzel Formula and Nomograph to this Section.
   3. Apply evaporation retardant again after each finishing operation as necessary to prevent drying shrinkage cracks.
   4. Do not work evaporation retardant into the surface of the concrete.
   5. Do not use evaporation retardant as finishing aid (to rehydrate surface a creamy state for finishing).
   6. Concrete surfaces in direct contact with potable water in the finished work:
      a. After curing is complete, pressure wash concrete, using equipment and procedures acceptable to the Engineer, to remove residual evaporation retardant and other compounds prior to cleaning structure for disinfection.

C. Concrete sealer:
   1. Floors and slabs to receive concrete sealer: See Room Finish Schedule on the Drawings, and Section 03366 - Concrete Finishes.

3.07 CURING

A. Cure concrete by methods specified in this Section.

B. For placements of Class M concrete, as specified in Section 03703 - Thermal Control of Concrete for additional requirements.

C. Cure period: Keep concrete continuously moist and at an average daily temperature of at least 50 degrees Fahrenheit for a minimum of 7 days after placement.
   1. If hourly temperatures at any surface of a concrete placement drop below 50 degrees Fahrenheit during the curing period, count the period below 50 degrees Fahrenheit as zero degrees, and extend the curing time to compensate.

D. Schedule of curing methods:
   1. Cure the following concrete surfaces using water curing, or plastic membrane curing.
      a. Floor surfaces of water containment structures.
      b. Surfaces where additional concrete will be placed over or against the surface, including concrete joints.
      c. Surfaces where grout or other toppings will be placed over the surface.

d. Slabs scheduled to receive concrete sealer, or other bonded or adhered architectural finishes.
e. Formed surfaces scheduled to receive coatings, paint, adhered masonry, cementitious materials, or other similar finishes, and where formwork is removed within the specified cure period after concrete placement.
f. Horizontal concrete surfaces at tops of walls.

2. Cure the following concrete surfaces by water curing, plastic membrane curing, or sprayed curing membrane. Selection of methods shall be at the Contractor's option.
   a. Surfaces not listed in the preceding paragraph.

E. Water curing:
1. Keep surfaces of concrete constantly and visibly wet, day and night, for not less than the specified cure period.
   a. Each day forms remain in place will be counted as 1 day of water curing.
   b. Do not loosen form ties during period when concrete is cured by leaving forms in place. No further curing credit will be allowed for forms remaining in place after contact has been broken between concrete surface and forms.
2. Begin water curing as soon as concrete attains initial set.
3. Maintain a wet surface by ponding, continuous sprinkling, covering with saturated burlap, or otherwise saturating the surface by means acceptable to the Engineer.
   a. Flood top of walls with water at least 3 times per day and keep surfaces moist at all times during the curing period.
   b. Provide plastic sheet material over surfaces if required to maintain a wet surface during arid or windy conditions. See plastic membrane curing requirements for additional details.
4. Use water having a temperature within 20 degrees Fahrenheit of the temperature of concrete, and not lower than the minimum temperature allowed for the concrete surface during curing.

F. Plastic membrane curing:
1. Install plastic membrane as soon as concrete is finished and can support limited pedestrian traffic without damage.
2. Cover entire surface of finished concrete with membrane.
3. Anchor membrane to prevent uplift from wind or air trapped below the sheet.
4. Fully seal joints and edges to provide full seal around perimeter.
5. Keep concrete under plastic membrane moist, regularly monitoring surfaces and adding supplemental moisture if necessary. Add water as specified for water curing.

G. Sprayed membrane curing compound:
1. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   a. If more than 1 hour elapses after removal of forms, do not use membrane curing compound. Instead, provide water curing for not less than the specified cure period.
   b. Do not remove sprayed membrane curing compound from concrete before the end of the specified cure period.

c. When application of curing compound at concrete joints is accepted by the Engineer, take care to apply curing compound to all surfaces along full profile of joints.

2. Apply curing compound by mechanical, power operated sprayer with mechanical agitator that will uniformly mix all pigment and compound.
   a. Apply curing compound in at least 2 coats.
   b. Apply each coat in direction turned 90 degrees from application direction of the preceding coat.
   c. Apply curing compound in sufficient quantity so that concrete has uniform appearance and its natural color is effectively and completely concealed immediately after spraying.
   d. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
3. Thickness and coverage of curing compound:
   a. Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
   b. Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and is more than is customary in the trade. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
4. If the Contractor desires to use a curing compound other than specified product, coat sample areas of concrete wall with proposed curing compound, and also coat similar adjacent area with the specified compound in the manner specified, for comparison:
   a. If proposed sample is not equal or better, in the opinion of the Engineer, the proposed substitution will not be allowed.
5. Removal of curing compound.
   a. After curing period is complete, remove curing compound placed on surfaces that will receive additional concrete, including all concrete joint surfaces, by heavy sandblasting or by other means acceptable to the Engineer. Complete removal and cleanup prior to placing any new concrete against the surface.
   b. Where additional finishes will be applied over concrete surfaces, unless otherwise recommended by the manufacturer of the finish to be applied, remove curing compound by sandblasting. Provide blasting as necessary to fully remove curing compound.
6. Prior to final acceptance of the Work, remove, by sandblasting or by other method acceptable to the Engineer, any curing compound on surfaces exposed to process water or exposed to view, so that only natural color of finished concrete is visible and uniform over the entire surface.

3.08 PROTECTION

A. General:
   1. Keep forms in place, as specified in Section 03102 - Concrete Formwork, to provide curing and to protect concrete surfaces and edges from damage.
   2. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified.

B. Loading of concrete members:
   1. Placement of loads on or against green concrete is not permitted.
   2. Do not place soil against walls, or fill over the top of concrete until conditions designated in the following paragraphs are satisfied:
      a. Walls have been cast to their full height in the structure and have achieved their minimum specified 28-day compressive strength.
      b. Connecting slabs and beams that brace the walls are in place, are complete, and (in the case of concrete) have achieved their minimum specified 28-day compressive strength.

3.09 COLD WEATHER CONCRETING

A. Implement cold weather concreting procedures during periods of cold weather as defined in this Section.
   1. Comply with the recommendations of ACI PRC-306 and this Section.

B. Prepare a cold weather concreting plan. Maintain at least 1 copy of the plan on site. Provide plan for review if requested by the Engineer.
   1. Include procedures for batching, delivery, placement, curing, protection, and for monitoring and recording the temperature of the concrete and the surrounding environment.
   2. Describe procedure to be implemented in the event of abrupt changes in weather conditions or of equipment failure.
   3. Review cold weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by the Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete over frozen subgrade materials. Provide insulating material and supplementary heat if required to maintain a thawed surface.
   2. Do not place concrete around metallic elements whose temperature is less than 40 degrees Fahrenheit. If heating is required, use processes that do not alter the metallurgical properties of the elements.
   3. Remove snow, ice, and frost from reinforcement, embedments and forms. Schedule such removal immediately before concrete placement so that surfaces do not refreeze.

D. Batching, delivery, placement and finishing:
   1. Accelerating admixtures will not be permitted.
   2. Based on temperature of the environment and the surfaces where concrete will be placed, select and maintain mix temperature as recommended in ACI PRC-306.
      a. Make provisions for temperature loss during delivery and placing.
      b. Place concrete at or slightly above the minimum recommended batch temperatures. Do not exceed these minimum values by more than 20 degrees Fahrenheit.
   3. Heating: If temperature of water or aggregates is below 35 degrees Fahrenheit, heat the materials.
      a. Mixing water: Do not heat above 140 degrees Fahrenheit.
      b. Aggregates:
         1) Heat uniformly to eliminate ice, snow, and frozen lumps of material.

2) Avoid overheating.
3) Do not exceed average temperature of 140 degrees Fahrenheit or spot temperature of 200 degrees Fahrenheit.

E. Protection and curing:
1. Protect concrete to provide continuous warm moist curing immediately after placement and during protection period.
2. Minimum protection period: 7 days**.**
3. For placements of Class M concrete, do not use steam or other concrete heating methods that will increase concrete temperature outside the limits of Section 03703 - Thermal Control of Concrete.
4. During and immediately after the protection period, maintain temperature in accordance with Table 5 of this Section. Provide record of temperature during placement and curing as specified in the following paragraphs.
a. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete.

Table 5: Concrete Temperatures - Normal Weight Concrete			
Section Thickness (inches)	<12	12 to <36	36 to <72
During Protection Period: As maintained (minimum)	55°F	50°F	45°F
After Protection Period: Gradual drop during first 24 hours (maximum)	50°F	40°F	35°F

5. Provide plastic sheeting, polystyrene foam sheets, insulating blankets, and supplemental heating if required to maintain moisture and the specified temperatures during protection.
a. Protect insulating blankets from moisture in the concrete and from rain or snow using impermeable sheeting.
b. Supplemental heating units:
1) Vent units to outside atmosphere. Do not exhaust heater flue gasses into the enclosed and protected area.
2) Make provisions to heat the flow freely within protected area, and to maintain a uniform temperature throughout the space.
3) Locate units to avoid local drying or uneven heating of concrete surfaces.
c. Pay particular attention to maintaining required temperature and moisture at edges and corners.
6. At the end of the protection period, allow concrete to cool gradually to the ambient temperature.
a. Maximum temperature drop over the first 24-hour period shall be as specified above.
b. Where temperature of concrete exceeds ambient by 20 degrees Fahrenheit or more, loosen forms and leave in place for at least 24 hours before removal.
c. If water curing has been used, maintain concrete temperature as specified in the following paragraphs for at least 24 hours after water curing is terminated. Allow water-cured concrete to air dry for at least 3 days before exposure to freezing temperatures.

F. Temperature records:
   1. For each area of concrete placed or cured during cold weather, record the temperature of concrete and the ambient environment.
      a. Maintain temperature records on site and make records available for review by the Engineer upon request.
      b. Deliver a final copy of each record to the Engineer for project files not more than 14 calendar days after the date concrete was placed.
   2. Concrete delivered for placement.
      a. Measure and record temperature at the point of discharge in accordance with ASTM C1064.
      b. Note temperature on the batch ticket.
   3. Concrete during the protection period:
      a. Furnish and locate self-recording thermometers (maximum/minimum) around each placement. Number and location of thermometers shall be sufficient to represent temperatures around the entire concrete placement.
      b. Position thermometers to record the temperature at each edge or corner and at the middle of the placement area.
   4. Include in the temperature record of each placement the following information, recorded legibly on a single sheet.
   5. In the event that evaluations of the efficacy of concrete protection and curing are required, the lowest temperature recorded in any placement during each 24-hour period will be assumed to be the temperature at which the entire placement was maintained. Protection periods with any temperature records will be assumed to have provided no protection or curing, and the protection period will be extended by 2 days for each day without protection.

3.10 HOT WEATHER CONCRETING

A. Implement hot weather concrete procedures during periods of hot weather as defined in this Section.
   1. Comply with the recommendations of ACI PRC-305 and this Section.

B. If placements during hot weather are expected, and when requested by the Engineer, prepare a hot weather concreting plan.
   1. Maintain at least 1 copy on site.
   2. Provide plan for review if requested by the Engineer.
      a. Include procedures for batching, delivery, placement, curing, protection, and monitoring and recording the temperature of the concrete and the surrounding environment.
      b. Describe procedures to be implemented in the event of abrupt changes in weather conditions, or in the event of equipment failure.
      c. Review hot weather concreting plan during pre-construction meeting. Make provisions to address any concerns expressed by the Engineer before beginning concrete placements.

C. Preparation:
   1. Do not place concrete against forms, reinforcement, or embedments with a surface temperature greater than 120 degrees Fahrenheit.
      a. If necessary, to maintain maximum concrete temperature during placing, cool forms and reinforcement to temperature below 90 degrees Fahrenheit using water or shades.

b. Do not allow water to puddle in forms or placement areas.

2. Moisten forms or subgrade to maintain a saturated surface without standing water or soft spots.
3. Provide windbreaks, shades, fog spray, sprinkling, wet cover, or other means required to protect concrete from premature loss of moisture and rapid temperature gain.

D. Batching and delivery:
   1. Retarding admixtures will not be permitted.
   2. Temperature of concrete delivered for placement shall not exceed 90 degrees Fahrenheit.
      a. Maintain uniform temperature in the mix below this level during batching, delivery, placing, and consolidation.
      b. Temperature of mix, even if below the maximum allowable temperature specified, shall be maintained at a level to avoid loss of slump, flash setting, or cold joints in placements.
   3. If necessary:
      a. Mix water may be chilled or replaced with ice to maintain mix temperature. Where mix water is replaced with ice, provide replacement at a 1-to-1 ratio by weight.
      b. Shade transit mixed concrete trucks, or cool mixing outside of container with water to control temperature of concrete.

E. Placing and finishing:
   1. Place and finish concrete promptly. Place so that vertical lift lines will not be visible in exposed concrete surfaces.
   2. Provide plastic sheeting, fog nozzles, shades or other means to reduce concrete temperature and protect from moisture loss.
   3. For placements of Class M concrete, use fog sprayers to reduce ambient air temperature and increase humidity during concrete placement.

F. Protection and curing:
   1. Furnish and locate maximum/minimum temperature recording thermometers in sufficient numbers to confirm concrete temperatures over full area and edges of concrete.
   2. Flatwork: Protect and cure using water curing methods as specified in this Section.
      a. Water curing:
         1) Keep concrete continuously wet and make provisions for runoff.
         2) For sprinkling or soaker hoses, maintain temperature of water as close as possible to the temperature of the concrete to minimize effects of thermal shock.
   3. Formed surfaces: Protect and cure using forms left in place or membrane curing methods as specified in this Section.
      a. Cover forms and keep continuously moist for at least 24 hours after placement.
      b. Loosen forms as soon as this can be accomplished without damaging the concrete.
      c. Maintain continuously moist surfaces by fogging or spraying with water, or by application of curing compound as specified.

3.11 FIELD QUALITY CONTROL BY CONTRACTOR

A. Provide quality control over the Work of this Section as required by Section 01450 - Quality Control.

B. Temperature Monitoring Program:
   1. For placements of Class M concrete, execute temperature monitoring program required in Section 03703 - Thermal Control of Concrete.

C. Field tests:
   1. During progress of construction, provide testing to determine whether the concrete, as being produced, complies with requirements specified.
   2. Sampling and testing shall be performed by the Contractor's testing laboratory. See Section 01455 - Regulatory Quality Assurance - Special Tests and Inspections for requirements.
      a. Cooperate in testing by allowing free access to the Work for testing laboratory to sample and test materials.
      b. Provide full access for the Engineer to observe concrete sampling and testing at any time.
      c. Contractor is responsible for providing care of and curing conditions for test specimens in accordance with ASTM C31 until specimens are collected by testing laboratory.
      d. Provide 4 firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold 10 specimens. Include cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication through shipment to the Owner's testing laboratory.
   3. Testing shall include:
      a. Sampling of concrete in accordance with ASTM C172.
      b. Temperature of concrete at delivery in accordance with the requirements of ASTM C1064 and as specified in this Section.
      c. Slump of concrete using slump cone in accordance with requirements of ASTM C143. Test slump at the following intervals:
         1) At the beginning of each placement.
         2) As often as necessary to keep slump within the specified range, but not less than every 6th truck.
         3) When requested to do so by the Engineer.
         4) Observe concrete during slump test for signs of segregation.
            a) Observe concrete to see if mortar or moisture flows from slumped concrete.
            b) Reject concrete if mortar or moisture flows out of mix.
      d. Unit weight of concrete in accordance with ASTM C138.
      e. Air entrainment in accordance with ASTM C173. Test air content at the following intervals:
         1) At beginning of each placement.
         2) As often as necessary to keep entrained air within specified range, but not less than every 6th truck.
         3) When requested to do so by the Engineer.
         4) Test air entrainment in concrete in accordance with ASTM C173. If air entraining admixtures used for the Work require alternate testing procedures, advise the independent testing laboratory well in

advance of the dates of testing, and confirm that appropriate equipment and personnel are provided for the test.

5) Make air test at point of delivery (discharge from mixer). For pumped concrete, make air tests at point of delivery and at point where expelled after pumping for placement.

f. Compressive strength in accordance with ASTM C39. Required number of cylinders is as follows:

1) Not less than 6 cylinder specimens, 4 inches in diameter by 8 inches long, will be tested for each 150 cubic yards of each class of concrete, with minimum of 6 specimens for each class of concrete placed; not less than 6 specimens for each half day's placement; and not less than 2 sets of 6 specimens for each structure.

2) 1 cylinder will be broken at 7 days, 1 at 14 days, and 3 at 28 days. 6th cylinder may be used to evaluate strength after 28 days if requested by the Engineer.

3) Retain and store "6th cylinders" (tested and untested) at testing laboratory until 56 days. Break "6th cylinder" when directed by the Engineer.

g. Provide full access for the Engineer to observe concrete sampling and testing at any time.

D. Test completed liquid containment structures listed in Section 01759 - Water Leakage Test for Concrete Structures for watertightness.

3.12 FIELD QUALITY CONTROL BY OWNER

A. As specified in Section 01450 - Quality Control.

B. Special tests and inspections: As specified in Section 01455 - Regulatory Quality Assurance.

C. Field inspections:

1. Observe construction for conformance to the Contract Documents and the accepted submittals.
2. Records of inspections:
   a. Provide a record of each inspection.
   b. Submit copies to the Contractor upon request.

D. Field tests:

1. Engineer may request, at any time, additional testing to confirm materials being delivered and placed conform to the requirements of the Contract Documents.
   a. If such additional testing shows that the material do not conform to the specified requirements, the Contractor shall pay the cost of these tests.
   b. If such additional testing shows that the materials do conform to the specified requirements, the Owner will pay the cost of these tests.

3.13 NON-CONFORMING WORK

A. Remove and replace or repair non-conforming and defective work.
   1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
   2. Provide replacement or repair of non-conforming work by means acceptable to the Engineer and at no additional cost to the Owner.
   3. Project schedule will not be extended based on work to address non-conforming concrete.

B. Concrete not conforming to the specified requirements for properties of plastic concrete: Remove from the site and replace with conforming materials at no additional cost to the Owner.
   1. Temperature: Do not use concrete having a temperature above or below the limits specified in this Section.
   2. Slump: Do not place concrete that does not conform to requirements for slump.
   3. Air entrainment: Do not use concrete that does not conform to requirements for percentage of entrained air.

C. Concrete not conforming to the specified requirements for compressive strength:
   1. Concrete is expected to reach a compressive strength equal to or greater than the minimum specified compressive strength f'c in Table 3 of this Section.
   2. Strength of concrete will be considered acceptable if the following conditions are satisfied.
      a. Averages of all sets of 3 consecutive strength test results is greater than or equal to the specified compressive strength f'c.
      b. No individual strength test (average of 3 cylinders) falls below the strength specified in Table 6 of this Section.
      c. Where relationships between 7-day and 28-day compressive strength, or between 28-day and 56-day compressive strength, have been provided as part of the mix design submittals:
         1) 7-day strength may be considered as an indication of 28-day strength provided effects of temperature and humidity between 7 days and 28 days are taken into account.
         2) 28-day strength may be considered as indication of 56-day strength provided effects of temperature and humidity between 28 days and 56 days are taken into account.

Table 6: Strength Compliance Requirements

Minimum Specified Compressive Strength, f'c (pounds per square inch)	Lower Bound of an Individual Compressive Strength Test (pounds per square inch)
Less than 5,000	f'c - 500
Over 5,000	f'c - (0.10 x f'c)

   3. Non-compliant strength tests.
      a. Mark non-compliant strength test reports to highlight the non-complying results, and immediately forward copies to all parties on the test report distribution list.

b. Initial treatment may consist of additional curing of affected portion(s) followed by not less than 3 cores at each affected area, taken in accordance with ASTM C42 and ACI CODE-318. Obtain the Engineer's acceptance of proposed coring locations before proceeding with that work.
c. Submit report of compressive strength testing for the Engineer's review.
d. If requested by the Engineer, provide additional cores, and obtain petrographic testing in accordance with ASTM C856. Submit results for the Engineer's review.
e. If additional curing does not bring the average strength of 3 cores taken in affected area to at least specified compressive strength f'c, designate such concrete in affected area will be considered defective.
f. Engineer may require the Contractor to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all at the Contractor's expense.

D. Concrete sections or surfaces with honeycombing and voids:
1. Provide repairs having surface appearance and finish consistent with that of the surrounding work and acceptable to the Engineer.
2. Do not patch, repair, or cover defective Work without prior inspection by the Engineer.
3. Preparation of concrete for repair:
a. Make no repair until the Engineer has accepted methods for preparing surfaces and for making and curing repairs.
b. Chip out and key-in imperfections in the Work to make them ready for repair.
c. Coat bonding surfaces and edges of repair area with one of the following bonding agents as accepted by the Engineer.
1) Epoxy bonding agent as specified in Section 03071 - Epoxies.
2) Epoxy resin/Portland cement bonding agent as specified in Section 03072 - Epoxy Resin/Portland Cement Bonding Agent.
4. Methods of repair:
a. Dry pack mortar method:
1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
2) Smooth holes: Clean and roughen by heavy sandblasting before repair.
3) Install dry-pack mortar as specified in Section 03600 - Grouting.
b. Cement mortar method:
1) Use for holes too wide to dry pack and too shallow for concrete replacement; and for comparatively shallow depressions, large or small, that extend no deeper than nearest surface reinforcement.
2) Install cement mortar as specified in Section 03600 - Grouting.
c. Concrete replacement:
1) Use when holes extend entirely through the concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
2) Form, place, consolidate, and cure concrete of same mix as the surrounding work.

E. Leaking construction joints and cracks in concrete walls and slabs:
   1. Repair cracks that develop in walls or slabs, and repair cracks that show any signs of leakage until all leakage is stopped.
   2. Pressure inject visible cracks in the following areas, other than hairline cracks and crazing, with repair products and methods acceptable to the Engineer.
      a. Floors and walls of water bearing structures.
      b. Walls and overhead slabs of passageways and occupied spaces where the opposite face of the member is exposed to weather or may be washed down and where the opposite face does not receive a separate waterproofing membrane.
      c. Other items not specified to receive separate waterproofing membrane including slabs over water channels, wet wells, reservoirs, and other similar surfaces.
   3. Continue pressure injection of cracks as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

F. Leaking expansion joints in concrete walls or slabs that include waterstops:
   1. Repair any signs of leakage until all leakage is stopped.
   2. Pressure inject visible leaks with hydrophilic polyurethane foam resin as specified in Section 03933 - Hydrophilic and Hydrophobic Foam Polyurethane Resin Injection System.
   3. Continue pressure injection along joints lines as specified until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion or date of final repair, whichever occurs later in time.

G. Walls and slabs at overhead channels that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy.
   1. Seal on water or weather side by coating using surface-applied sealing system as specified in this Section.
   2. Apply as recommended by manufacturer published instructions. Where concrete continues to sweat or leak, apply additional coats of surface-applied sealing system until the sweating or leaks stop.
   3. Continue application of surface-applied sealing system until structure is watertight and remains watertight for not less than 1 year after date of Substantial Completion, or date of final repair, whichever occurs later in time.

END OF SECTION

ATTACHMENT A - MENZEL FORMULA AND NOMOGRAPH

MENZEL FORMULA AND NOMOGRAPH

Source: ACI PRC-305

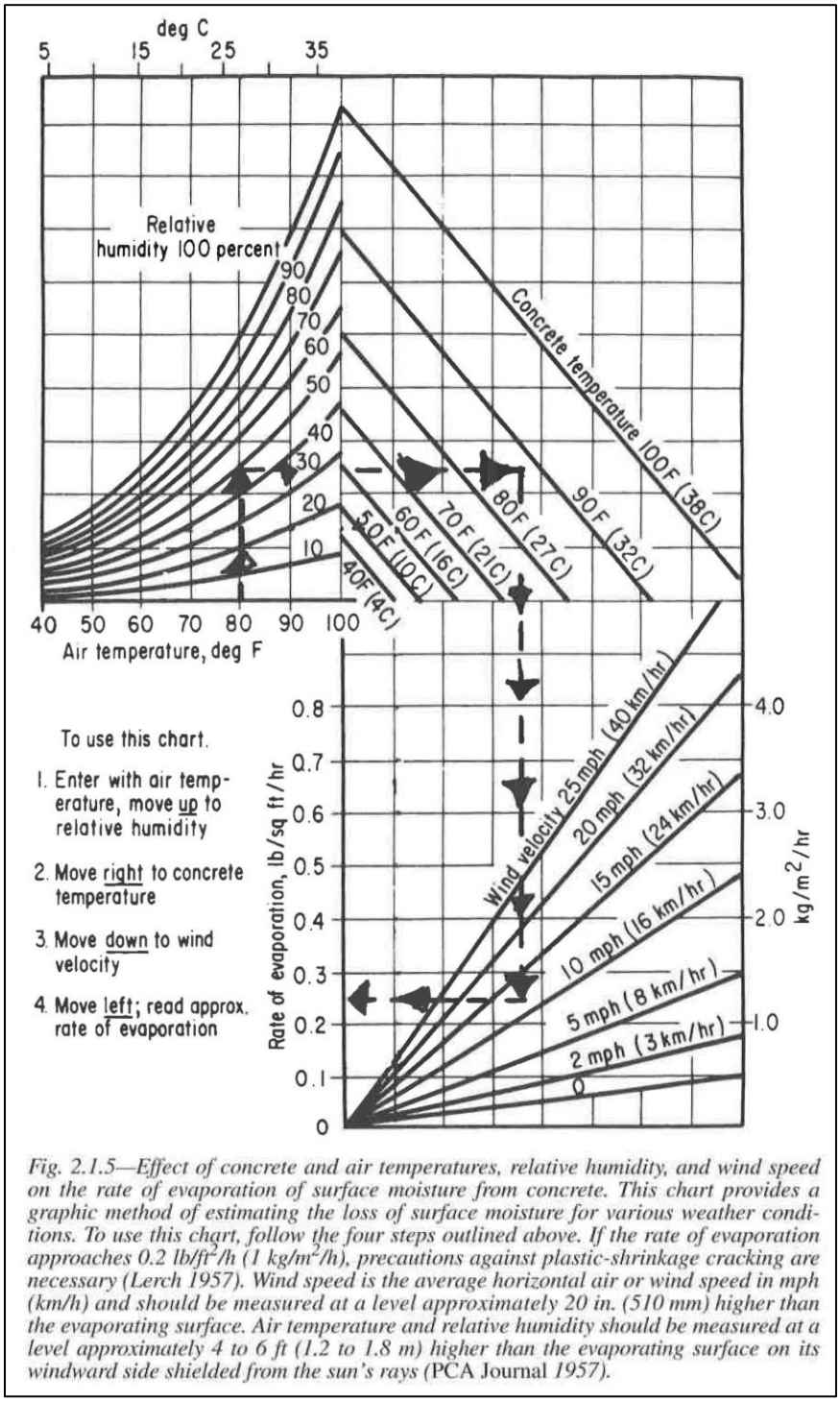


*Fig. 2.1.5—Effect of concrete and air temperatures, relative humidity, and wind speed on the rate of evaporation of surface moisture from concrete. This chart provides a graphic method of estimating the loss of surface moisture for various weather conditions. To use this chart, follow the four steps outlined above. If the rate of evaporation approaches 0.2 lb/ft²/h (1 kg/m²/h), precautions against plastic-shrinkage cracking are necessary (Lerch 1957). Wind speed is the average horizontal air or wind speed in mph (km/h) and should be measured at a level approximately 20 in. (510 mm) higher than the evaporating surface. Air temperature and relative humidity should be measured at a level approximately 4 to 6 ft (1.2 to 1.8 m) higher than the evaporating surface on its windward side shielded from the sun's rays (*PCA Journal *1957).*

ATTACHMENT B - COARSENESS FACTOR CHART

COARSENESS FACTOR CHART

Source: ACI PRC-302.1-15, Figure 8.9.2.2.

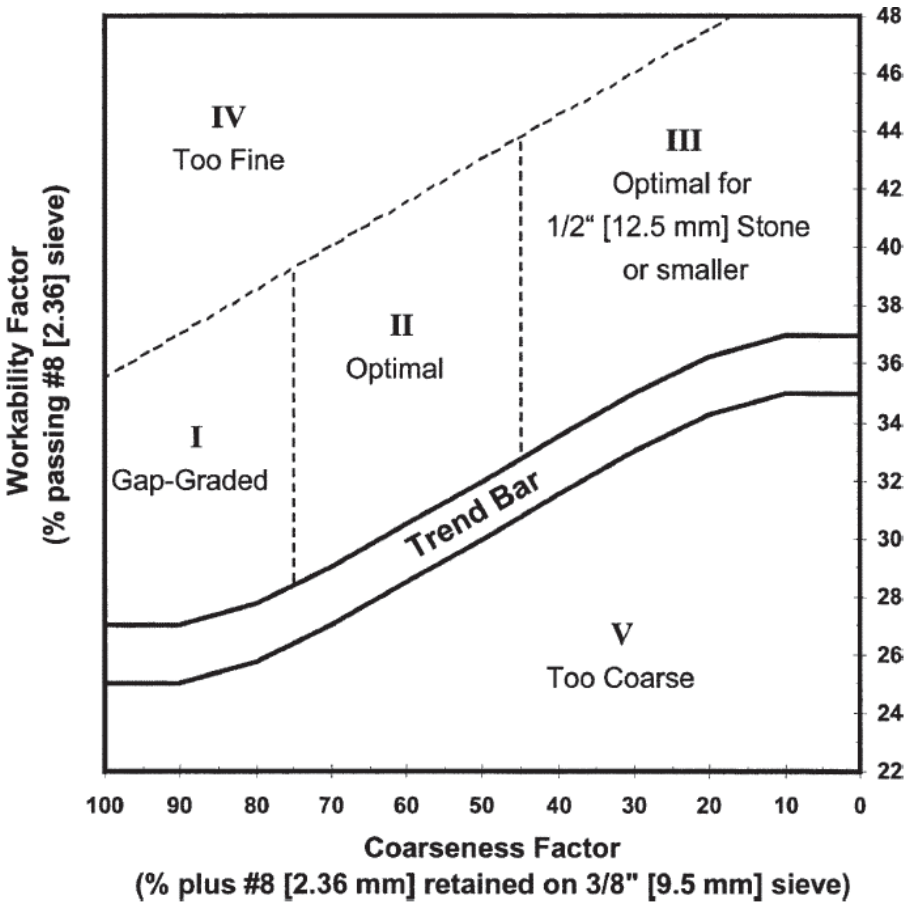
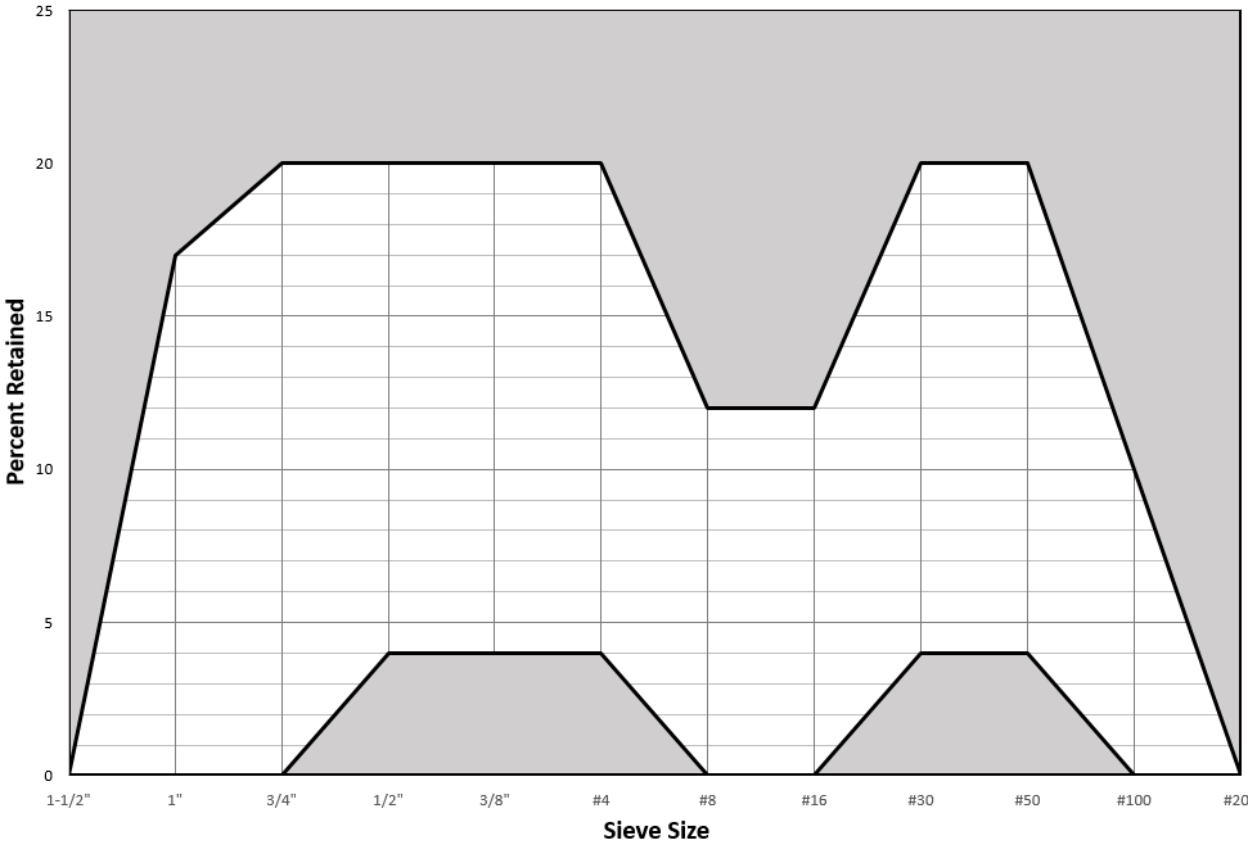


Fig. 8.9.2.2—Coarseness factor chart for evaluating potential performance of mixture.

ATTACHMENT C - COMBINED AGGREGATE GRADATION CHART

COMBINED AGGREGATE GRADATION CHART



ATTACHMENT D - CONCRETE PLACEMENT CHECKLIST

CONCRETE PLACEMENT CHECKLIST

Project: _____ Class of Concrete: _____

Project No: _____ Test Cylinders Taken? Yes: _____ No: _____

Preparation Slab	Contractor	N/A
Compaction Subgrade		
Filter Fabric/Drain Rock-ABC/Separator Fabric		
Drain Rock, Pea Gravel & Void Form		
Starter Wall Forms		
Reinforcing Steel		
Screeds		

Embedded Items	Contractor	N/A
A. Anchor Bolts		
B. Water Stop		
C. Rebar		
D. Electrical		
E. Plumbing Rough-in		
F. Mechanical		
G. HVAC		

Concrete Placement Equip.	Contractor	N/A
A. Crane		
B. Buckets		
C. Hoppers		
D. Vibrators		
E. Elephant trunks		
F. Floodlights		
G. Pump Truck		

Building Department Notification	
Date:	Time:

Prep Wall Concrete	Contractor	N/A
Access To Work		
Ladders Secured		
Clean up and Washed Out		
Reinforcing Steel		

Forms	Contractor	N/A
A. Alignment & Grade		
B. Scaffolding		
C. Sleeves & Wall Castings		
D. Embedded Items		
E. Electrical		
F. Plumbing Rough-in		
G. Piping		

Record of Curing Conditions During Placement	
Start:	Finish:
Date:	
Time:	
Weather:	
Temperature:	
Comments:	

Location of Placement _____

The Contractor certifies the above-proposed concrete placement is prepared as indicated and is in accord with the Contract Drawings and Specifications. The Contractor requests permission to begin placement of concrete on the date of _____ at _____. The estimated number of yards is _____. The estimated duration of the placement is _____.

By: _____
Contractor

Released for placement by: _____
Engineer

SECTION 03366

CONCRETE FINISHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Concrete finishes.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117-10 - Specification for Tolerances for Concrete Construction and Materials and Commentary.

B. International Concrete Repair institute (ICRI):
   1. Guideline No. 301.2: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Grade line: A reference line that separates surfaces considered to be above grade from those considered to be below grade. Located 12 inches below finished grades at the perimeter of the structure.
   2. Water line: A reference line that separates surfaces considered to be above the water level (and visible in the finished work) from those considered to be below the water level (and not visible in the finished work). For each water-bearing cell of a structure, defined as a line located 2 feet below the normal operating water level in that cell.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Finishing personnel:
      a. Use qualified flatwork finishers.
      b. Finishing supervisor must have at least 5 years of experience finishing concrete.

B. Mockups:
   1. Construct mockup panels showing the finishing of formed surfaces for review by the Engineer.
      a. Construct mockup panels demonstrating concrete finishes for vertical surfaces:
         1) Construct mockup panels for F4 and F5 finishes and tie-hole repairs for review by the Engineer.

2. Construct mockup slabs showing finishing of unformed surfaces for review by the Engineer.
    a. Construct mockup slabs demonstrating concrete finishes for horizontal surfaces:
        1) Construct mockup slabs for S1, S2, S4, and S5 finishes.
3. Include the following elements in mockup panels and slabs.
    a. Concrete joints:
        1) Horizontal and vertical joints of the types included in the Work.
    b. Concrete repairs:
        1) Repairs using materials and procedures proposed for the Work.
4. Construct mockup panels and slabs at beginning of project for review by the Engineer.
5. Panels and portions thereof accepted by the Engineer will serve as the standard of quality and workmanship for the Work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
    1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for mortar:
    1. As specified in Section 03300 - Cast-in-Place Concrete, unless otherwise noted.
    2. Where finished surfaces will be visible in the finished work, use same cement used for concrete batches in that area. Add white cement if required to obtain color match between base concrete and finishing mortars.

2.02 MIXES

A. Cement mortar:
    1. As specified in Section 03600 - Grouting.

B. Dry-pack mortar:
    1. As specified in Section 03600 - Grouting.

C. Mortar mix for F4 finish (“F4 Mortar”):
    1. Consisting of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

D. Mortar mix for F5 finish (“F5 Mortar”):
    1. Consisting of 1 part cement to 1-1/2 parts of sand passing Number 16 screen.

2.03 EVAPORATION RETARDANT

A. As specified in Section 03300 - Cast-in-Place Concrete.

2.04 NON-SLIP ABRASIVE

A. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate. Homogeneous, non-glazing, rust-proof, and unaffected by freezing, moisture, and cleaning compounds.

B. Manufacturers: One of the following, or equal:
   1. Abrasive Materials Incorporated, Hillsdale, MI.
   2. Exolon Company, Tonawanda, NY.

2.05 CONCRETE SEALERS

A. Floor sealer and dust-proofer:
   1. Non-membrane forming, breathable, non-yellowing, penetrating sealer designed to densify and seal a cured concrete surface.
   2. Low odor, VOC content of 0 grams per liter, and stable when exposed to ultraviolet radiation from sunlight.
   3. Manufacturers: One of the following, or equal:
      a. Dayton Superior: Day-Chem Sure Hard Densifier (J-17).
      b. Euclid Chemical Company: Euco Diamond Hard.
      c. L&M Construction Chemicals: Seal Hard.
      d. W.R. Meadows: Liqui-Hard.

PART 3 EXECUTION

3.01 CONCRETE FINISHING - FORMED SURFACES

A. Scope:
   1. Finish formed surfaces with one of the finishes specified in the following paragraphs and as indicated in the Schedule of Concrete Finishes in this Section.
   2. Formed surfaces are those surfaces that the plastic concrete is placed against a temporary containment surface that will be removed after the concrete sets and takes its final form.

B. General:
   1. Provide setting and curing time from casting of concrete to removal of forms as specified in Section 03300 - Cast-in-Place Concrete.
   2. Provide curing after removal of forms as specified in Section 03300 - Cast-in-Place Concrete.
   3. Materials and mixes for finishes.
      a. Cement: Add white cement to mortars and grouts used for finishing if required to match color of repairs to surrounding surfaces.
   4. Grinding:
      a. Where grinding of concrete surfaces is permitted:
         1) Perform grinding using an iron-free wheel, such as an aluminum oxide wheel, to avoid entrapment of particles that produce rust stains.
         2) At locations where plastic-protected reinforcing bar supports are used, limit grinding to a maximum depth of 1/16 inch.

C. F1 finish: “Rough Form Finish”:
   1. Repair defective work.
   2. Remove fins and other projections larger than 1 inch.
   3. Fill tie holes using dry-pack mortar.
   4. After removal of any curing compounds, fill depressions larger than 1 1/2-inch wide or 1/2-inch deep using dry-pack mortar.
   5. Leave surface with texture imparted by forms.
   6. Surface irregularity: Not exceeding a 1-inch gap when measured over the length of a 5-foot straightedge.

D. F2 finish: “Form Finish”:
   1. Repair defective work.
   2. Remove fins and other projections larger than 1/4 inch.
   3. Fill tie holes using dry-pack mortar.
   4. Fill depressions.
      a. Fill after removal of any curing compounds.
      b. Fill depressions larger than 3/4 inch in width or 1/2 inch in depth using cement mortar.
      c. Fill larger voids and depressions, use dry-pack mortar.
   5. Leave surfaces with texture imparted by forms.
   6. Surface irregularity: Not exceeding a 1/4-inch gap when measured over the length of a 5-foot straightedge.

E. F3 finish: “Smooth Form Finish”:
   1. Repair defective work.
   2. Repair rough or irregular surface finishes resulting from failure of form release agent or other form conditions and provide a smooth, uniform surface appearance.
   3. Remove fins: Grind offsets, projections, and rough spots larger than 1/8 inch smooth.
   4. Fill tie holes using dry pack mortar.
   5. Fill depressions:
      a. Fill after removal of any curing compounds.
      b. Fill depressions 1/2 inch and larger in depth or 3/4 inch in width using cement mortar.
      c. For larger depressions, fill using dry pack mortar.
   6. Top coat tie holes and filled depressions with cement mortar to provide uniform appearance.
   7. Leave surfaces with texture that is generally smooth and uniform in appearance.
   8. Surface irregularity: Not exceeding a 1/8 inch gap when measured over the length of a 5-foot straightedge.

F. F4 finish: “Rubbed Finish”:
   1. As specified for F3 finish, except prepare surfaces and fill depressions 1/16 inch or larger in depth or width as follows.
   2. Fill depressions.
      a. “Brush-off” sandblast surfaces to expose all depressions and voids near the surface of the concrete.
      b. Thoroughly wet surfaces and begin filling depressions while surfaces are still damp.

c. Use clean burlap, sponge rubber floats, or trowels to rub plastic F4 mortar over the entire surface to be finished. Fill pits, holes, and depressions.
d. Wipe surfaces clean. Do not leave any mortar on the surface, except that within the depressions.
e. Cure: Moist cure surfaces.

G. F5 finish: “Stoned Finish”:
1. As specified for F3 finish, except add stoned finish as follows:
2. Fill depressions:
a. Wet surfaces thoroughly with brush.
b. Rub wetted surfaces with a hard wood float dipped in water containing 2 pounds of Portland cement per gallon of water.
c. Rub surfaces until form marks and projections are removed.
d. Using a brush, spread plastic grindings from the rubbing operation uniformly over the surface. Work the material in to fill pits and small voids.
e. Cure: Moist cure brushed surfaces for at least 72 hours.
3. Finish surfaces:
a. After curing, obtain final finish by rubbing with a No. 50 grit carborundum stone.
b. Continue rubbing until the entire surface has a smooth texture and is uniform in color.
c. Cure: Continue curing for remainder of specified time.
4. Note: If surfaces have become too hard to finish as specified in the preceding paragraphs, the following alternative procedure may be used:
a. Sandblast and wash related surfaces exposed to view, whether finished or not.
b. While surfaces are still damp, rub surface with mortar mix for F5 finish.
c. Finish by rubbing mortared surface with No. 60 grit carborundum stone. Add F5 mortar until surface is evenly filled without excess mortar. Continue stoning until surface is hard.
d. Moist cure surface for 72 hours.
e. After curing, make the surface smooth in texture and uniform in color by rubbing with a No. 50 or No. 60 grit carborundum stone.
f. Continue curing until 7-day curing period is complete.

3.02 CONCRETE FINISHING - UNFORMED SURFACES

A. Scope:
1. Finish unformed surfaces with one of the finishes specified in the following paragraphs and as indicated in the Schedule of Concrete Finishes in this Section.
2. Unformed surfaces are those surfaces that are not cast against a temporary containment and the specified finish is achieved by tooling.

B. General:
1. Concrete placement:
a. Place concrete at a rate that allows spreading, straight-edging, and initial floating before bleed water appears.
1) Consider characteristics of concrete mixes used, including potential for accelerating or retarding effects of admixtures, fly ash, and temperatures, on plans for and scheduling of placement and finishing.

b. Place, consolidate, strike-off, and screed concrete level to bring surfaces to required planes and lines. Eliminate high and low spots.
c. Strike tops of walls and similar surfaces smooth and finish as specified to a texture consistent with that of adjacent formed surfaces.
d. After screeding, apply evaporation retardant to concrete surface if weather conditions will result in rapid evaporation of moisture from the surface of the concrete. Do not work evaporation retardant into the surface of the concrete.

2. Floating and re-straightening:
   a. Float concrete to compact and consolidate the surface.
   b. Initial floating:
      1) Provide initial floating immediately after screeding.
      2) Perform by hand using a wide bull float, darby, or highway straightedge.
      3) Complete before excess moisture or bleed water is present on the surface.
   c. Wait for concrete to stiffen and for the bleed water to stop rising and dissipate before proceeding with edging, hand-tooled jointing, and second floating.
   d. After initial floating, apply evaporation retardant to concrete surface if weather conditions will result in rapid evaporation of moisture from the surface of the concrete. Do not work evaporation retardant into the surface of the concrete.
   e. Second floating:
      1) Do not commence until bleed water has dissipated and concrete has stiffened enough to support weight of finishers and finishing equipment.
      2) May be by hand, or, if accepted by the Engineer, may be done using a bladed power float equipped with float shoes, or a power disk float.
      3) Float surfaces to a true, even plane, with no coarse aggregate visible.
      4) Evaporation retardant may not be applied after second floating.
   f. Flatness:
      1) Specified tolerances for flatness may require re-straightening of the surface between first and second floating operations and before steel troweling. Re-straighten concrete as required.
      2) Modify power equipment with alternate float shoes or other equipment if required to achieve specified flatness.

3. Troweling: Where finishes require troweling, conform to the following requirements:
   a. After surface moisture from floating has disappeared, steel trowel to a smooth, hard, dense concrete surface.
   b. Provide at least 2 trowelings.
      1) Avoid excessive troweling.
      2) Use smaller trowels for successive troweling.
      3) Make each successive troweling perpendicular to the previous pass.
   c. Do not add dry cement or additional water to the surface during troweling.
   d. In lieu of hand steel troweling, a power machine for finishing concrete may be used if accepted by the Engineer.
      1) Do not use power machine if concrete has not attained the set necessary to permit finishing without introduction of high and low spots into the concrete surface.

2) Use equipment in full compliance with the manufacturer's recommendations.
3) Use smaller blades or higher pressure for each successive troweling.
4) Hand trowel areas of the concrete not accessible to power equipment.
5) Tolerances for flatness specified may require re-straightening of the surface during finishing. Modify power equipment with alternate shoes or other equipment if required to achieve these requirements.

e. Finishing with a fresno trowel or finishing to a "fresno finish" is not allowed.

4. Finishing tolerances:
   a. Slabs sloped to drain: Finish surfaces to adequately drain toward designated points or lines, regardless of tolerances specified.

C. S1 finish: "Scratch Finish":
1. Place, consolidate, and screed concrete level.
2. Provide initial floating of concrete.
3. Provide surface conforming to the "Conventional" floor flatness tolerance requirements of ACI 117 using the manual straightedge method (maximum 1/2-inch gap in 10 feet at 90 percent of locations; maximum 3/4-inch gap at any location), unless otherwise indicated.
4. Before final set, roughen the surface with rakes.
   a. For sloped surfaces, rake grooves in the direction of drainage.
   b. Provide roughness equivalent to CSP 6 surface as designated by ICRI Guideline 310.2.
5. Pressure wash surface to remove laitance before placing grout or toppings.

D. S2 finish: "Floated Finish":
1. Place, consolidate, and screed concrete to required elevations and slopes.
2. Provide initial and second floatings of concrete. Float to a uniform texture.
3. Provide surface conforming to the "Flat" floor flatness tolerance requirements of ACI 117 using the manual straightedge method (maximum 1/4-inch gap in 10 feet at 90 percent of locations; maximum 3/8-inch gap at any location), unless otherwise indicated.
4. Remove laitance and leave surface clean.

E. S3 finish: "Steel Trowel Finish":
1. Place, consolidate, and screed concrete to required elevations and slopes.
2. Provide S2 Floated Finish.
3. Provide 2 trowelings:
4. Provide finish conforming to the "Flat" floor flatness tolerance requirements of ACI 117 (maximum 1/4-inch gap in 10 feet), unless otherwise indicated.

F. S4 finish: "Steel Trowel Finish - Free of Trowel Marks":
1. Finish as specified for S3 Steel Trowel Finish, except that final troweling shall remove all trowel marks from the slab surface.

G. S5 finish: "Broomed Finish":
1. Finish as specified for S2 Floated Finish, except modify as follows:
2. Finish surface by drawing a fine-hair broom lightly across the freshly floated surface.
   a. Provide resulting roughness for a non-skid surface. Finishing and roughness is subject to review and acceptance by the Engineer.

b. Direction of brooming:
    1) General:
        a) In same direction of and parallel to expansion joints.
        b) Perpendicular to primary direction of traffic.
    2) For sloped slabs, parallel to the direction of drainage.
    3) For round roof slabs, in the radial direction.

H. S6 finish: “Non-Slip Abrasive Finish”:
1. Place, consolidate, and screed concrete to required elevations and slopes.
2. Provide initial floating of surface.
3. Prepare and apply abrasive as recommended by the manufacturer.
    a. Apply using a shake screen or other accepted method to ensure even coverage without segregation of the abrasive.
    b. Install abrasive at a rate of 25 pounds for each 100 square feet of surface area.
4. After concrete has hardened enough to support the weight of a person, and unless otherwise indicated by the abrasive manufacturer, apply approximately 2/3 of the abrasive material required for coverage.
5. Finish as specified for S2 Floated Finish, except that re-floating is not required.
6. Apply remaining abrasive material at right angles to the first application and in locations necessary to provide the minimum specified thickness.
7. Immediately after the second application, re-float the surface to embed abrasive.
8. Finish as specified for S2 Steel Trowel Finish. Trowel abrasive into the surface, properly exposing material to produce a non-slip finish.

I. Concrete sealer:
1. See Room Finish Schedule Drawings for locations of floors and slabs receiving concrete sealer finish.
2. Apply sealer in accordance with manufacturer’s instructions.

3.03 FIELD QUALITY CONTROL

A. Provide field quality control for the Work of this Section as specified in Section 01450 - Quality Control.

B. Field quality control by Contractor:
1. Field inspections and testing:
    a. Submit records of inspections and testing to Engineer within 24 hours after completion.
2. Manufacturer's services.
    a. Non-slip abrasive finish. Before beginning installation, conduct preinstallation meeting with manufacturer's technical representative to review product use and installation requirements.

C. Field quality control by Owner:
1. Special inspections, special tests, and structural observation:
    a. Not required.
2. Field inspections:
    a. Observe construction for conformance to the Contract Documents and the accepted Submittals.
    b. Provide record of each inspection. Submit copies to Engineer upon request.

3.04 NON-CONFORMING WORK

A. Unsatisfactory finishes that have hardened will require removal, grinding, topping, or other correction acceptable to the Engineer.

B. Re-work or refinish unsatisfactory finishes at no additional cost to the Owner.

C. See Section 03300 - Cast-In-Place Concrete for requirements.

3.05 SCHEDULE OF CONCRETE FINISHES

A. Formed surfaces: See Table 03366-A.

B. Unformed surfaces: See Table 03366-B.

Table 03366-A: Concrete Finishes - Formed Surfaces					
	Elements	**Location**	**Surface Exposure**	**Finish**	**Notes**
EXTERIOR SURFACES	Walls Columns Slab edges	Wet structure:	Above grade or water line:		
			- Exposed to view	F4	
			- Covered	F2	1a
			Below grade or water line:		
			- No coating	F1	
			- Bituminous coating	F2	
			- Waterproofing	F3	
		Dry structure:	Above grade line:		
			- Exposed to view	F4	
			- Covered	F2	1a
			Below grade line:		
			- No coating	F1	
			- Bituminous coating	F2	
			- Waterproofing	F3	
INTERIOR SURFACES	Walls Columns Slab edges	Wet structure:	Open basin:		
			- Above water line	F4	
			- Below water line	F3	
			Covered basin		
			- Above water line	F3	
			- Below water line	F3	
		Dry structure:	Exposed to view	F4	
			Covered	F2	1b
	Overhead slabs and beams	Wet structure:	Open basin	F3	1c, 1d
			Covered basin	F2	1d
		Dry structure:	Exposed	F3	1c, 1d
			Covered by ceiling	F1	1d

Notes:
(1a) Coverings include additional surfaces applied over the concrete, such as veneer, stucco, plaster, etc.
(1b) Coverings include additional surfaces applied over the concrete, such as veneer, stucco, plaster, furring strips with drywall, etc.
(1c) Applies to overhead surfaces visible from normal pedestrian travel routes.
(1d) At overhead slabs and beams, patch tie holes on sides of members.

Table 03366-B: Concrete Finishes - Unformed Surfaces					
	Element	**Location**	**Exposure**	**Finish**	**Notes**
EXTERIOR SURFACES	Footings	Extensions	Exposed	S3	
			Covered by soil	S2	
	Slabs and beams - exposed	Walking or possible walking paths	Tops of treatment structures	S5	2a, 2b, 2g
			Stairs & landings	S5	
		Roofs	Exposed	S5	
			Covered by roofing	S2	
	Slabs and beams - submerged	Unless otherwise noted	All	S3	2g
	Walls, Corbels	Top of wall or corbel	All	S3	One troweling
	Sidewalks	All		S5	
	Equipment Slabs	All		S5	
INTERIOR SURFACES	Floor slabs, includes flat and sloping surfaces	Wet structure	Exposed		
			- Basins & channels	S3	
			Covered		
			- To receive basin bottom grout	S1	2e
			- To receive concrete fill	S1	2f
		Dry structure	Exposed		
			- Pipe galleries	S4	2c
			- Stairs & landings	S4	2d
			- Shops & garages	S4	
			- Equipment rooms	S4	
			Covered		
			- Tile on mortar bed	S2	
			- Resilient flooring	S3	
			- Carpet	S3	

Notes:

(2a) Includes slabs covering tanks, basins, channels and similar structures.
(2b) Includes tops of walls or beams that serve as walkways.
(2c) In galleries with slabs subject to wetting, provide broom finish (S5) where indicated on the Drawings.
(2e) Finish for basin bottom grout.
(2f) Finish for concrete fill: See Floor slab, wet structure, exposed basins and channels.
(2g) Slabs include flat and sloping surfaces.

C. Finish concrete surfaces in accordance with Finish Schedule indicated on the Drawings.

END OF SECTION

SECTION 03600

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   4. Epoxy grout.
   5. Grout.
   6. Non-shrink epoxy grout.
   7. Non-shrink grout.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens).
   2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   3. C531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
   5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

B. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
   1. Mix design.
   2. Material Submittals.

B. Cement mortar:
   1. Mix design.
   2. Material Submittals.

C. Non-shrink epoxy grout:
   1. Manufacturer's literature.

D. Non-shrink grout:
   1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
   1. Manufacturers: One of the following, or equal:
      a. Five Star Products, Inc., Five Star DP Epoxy Grout.
      b. L&M Construction Chemicals, Inc., EPOGROUT.
      c. Master Builder Solutions/Sika, MasterFlow 648.
   2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
   3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
   4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
   5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
   6. Compressive creep: Not exceed 0.0037 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
   7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

B. Non-shrink grout:
   1. Manufacturers: One of the following, or equal:
      a. Five Star Products, Inc., Five Star Grout.
      b. L&M Construction Chemicals, Inc., CRYSTEX.
      c. Master Builder Solutions/Sika, MasterFlow 928.
   2. In accordance with ASTM C1107.
   3. Preportioned and prepackaged cement-based mixture.

4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
5. Require only addition of potable water.
6. Water for pre-soaking, mixing, and curing: Potable water.
7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
    a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
    a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
    b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

A. Cement grout:
    1. Use the same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
    2. Use same materials for cement grout that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
    4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
    1. Use the same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
    2. Use same materials for cement mortar that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
    4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
    1. Proportions by weight: 1 part Portland cement to 2 parts concrete sand.
        a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
        b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

D. Epoxy grout:
    1. Consist of mixture of epoxy or epoxy gel and sand.
        a. Epoxy: As specified in Section 03071 - Epoxies.
        b. Epoxy gel: As specified in Section 03071 - Epoxies.
        c. Sand: Clean, bagged, graded, and kiln-dried silica sand.

2. Proportioning:
    a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
    b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.

E. Grout:
1. Mix in proportions by weight: 1 part Portland cement to 4 parts concrete sand.
    a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
    b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

F. Non-shrink epoxy grout:
1. Mix in accordance with manufacturer's installation instructions.

G. Non-shrink grout:
1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
    a. Remove loose or broken concrete.
3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
1. Cement grout:
    a. Use mortar mixer with moving paddles.
    b. Pre-wet mixer and empty out excess water before beginning mixing.
2. Cement mortar:
    a. Use mortar mixer with moving paddles.
    b. Pre-wet mixer and empty out excess water before beginning mixing.
3. Dry-patch mortar:
    a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.

4. Non-shrink epoxy grout:
    a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
5. Non-shrink grout:
    a. May be dry packed, flowed, or pumped into place. Do not overwork grout.
    b. Do not retemper by adding more water after grout stiffens.

B. Placement:
1. Cement grout:
    a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
    b. Do not use cement grout that has not been placed within 30 minutes after mixing.
2. Cement mortar:
    a. Use mortar mixer with moving paddles.
    b. Pre-wet mixer and empty out excess water before beginning mixing.
3. Epoxy grouts:
    a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
4. Non-shrink epoxy grout:
    a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
    b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
5. Non-shrink grout:
    a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
    b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
1. Cement based grouts and mortars:
    a. Keep continuously wet for a minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
    b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
2. Epoxy based grouts:
    a. Cure grouts in accordance with manufacturers' recommendations.
        1) Do not water cure epoxy grouts.
    b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Grouting other baseplates:
1. General:
    a. Use non-shrink grout as specified in this Section.

b. Baseplate grouting shall take place from 1 side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.

2. Forms and headboxes:
a. Build forms using material with adequate strength to withstand placement of grouts.
b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on 1 side of baseplate.
e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.

B. Non-shrink grout:
1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 03703

THERMAL CONTROL OF CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Monitoring and control of concrete hydration temperatures during set and curing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C150 - Standard Specification for Portland Cement.

1.03 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Thermal control plan.

1.04 SUBMITTALS

A. Furnish Submittals as specified in Section 01330 - Submittal Procedures and Section 01600 - Product Requirements.

B. Product data.

C. Delegated Design Submittals:
   1. Thermal control plan.

D. Temperature monitoring program.

E. Temperature monitoring data:
   1. Tabular data of hourly concrete temperature for each temperature sensor.
   2. Tabular data for hourly concrete temperature differential for each temperature sensor.
   3. Plot of temperature and temperature differential for each temperature sensor.

F. Cooling pipe system, if used:
   1. Layout showing pipe sizes and material(s), connections, positions and spacing within the concrete, methods of support, and system for monitoring temperature of water in cooling pipes.
   2. Grout material for filling pipes.

1.05 QUALITY ASSURANCE

A. Engineer in responsible charge of development of the thermal control plan shall be a professional engineer and have the following qualifications:
   1. At least 10 years recent experience in completion of thermal control plans.
   2. Completion of thermal control plans of at least 20 successful projects. Provide contact references for at least 5 projects in the last 2 years.
   3. Engineer has determined that the following engineers are qualified to develop thermal control plans:
      a. Beton Consulting Engineers.
      b. MJ2 Consulting, PLLC.
   4. Contractor's request to use alternate engineers may be considered if qualifications and examples of work product are submitted to the Engineer for approval as follows:
      a. Cover letter listing the proposed engineer's qualifications.
      b. Examples of thermal control plans for 5 previous projects, including project name, date, location, and name of contact with telephone number.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
   1. Thermal control plan:
      a. General:
         1) Thermal control plan shall include the following as a minimum:
            a) Based on the range of average daily ambient air temperatures and initial concrete temperature at point of placement, calculate the following for each concrete placement:
               (1) Maximum concrete temperature.
               (2) Time from concrete placement until maximum concrete temperature occurs.
               (3) Maximum concrete differential temperature.
               (4) Time from concrete placement until maximum concrete differential temperature occurs.
               (5) Length of thermal control period.
            b) Concrete mix design as specified in Section 03300 - Cast-in-Place Concrete.
            c) Duration and method of curing.
            d) Procedures to control concrete temperature at time of placement.
            e) Methods of controlling maximum concrete differential temperature.
               (1) Include minimum temperature of adjacent concrete at construction joints.
            f) Temperature sensor types and placement locations.
            g) Temperature monitoring and recording system.
            h) Field measures to ensure conformance with maximum concrete temperature and maximum concrete temperature differential requirements.

i) Corrective measures to take if it appears specified concrete maximum temperature and maximum concrete differential temperature will be exceeded.

2) Have temperature control measures in place during the placement of concrete to limit maximum initial concrete temperature rise to 20 degrees Fahrenheit.
3) Difference in temperature between concrete interior and surface temperatures shall not exceed 35 degrees Fahrenheit.
4) Allow interior of concrete to cool down and stabilize.
5) Maximum allowable concrete temperature: 145 degrees Fahrenheit.
6) Do not place concrete until the Engineer has accepted in writing.

b. Pre-cooling of concrete:
1) Cool concrete mix prior to placement by the following means:
a) Cool batch water.
b) Ice may be substituted for portion of batch water.
c) Continuously spray coarse aggregate with water to cool aggregate. Adjust batch water content to account for added water content in aggregate due to use of cooling water.
d) Nitrogen injection.
e) Alternative means proposed by the Contractor that are acceptable to the Engineer.

c. Post-cooling of concrete:
1) Use embedded thin walled piping for circulating water to control temperature gain in previously cast concrete.
2) Clearly indicate in the thermal control plan if cooling piping will be embedded in concrete.
3) Do not install embedded piping within top 20 inches of slab or wall.
4) Operate cooling pipe system for duration of cooling period. Cooling period shall be a minimum of 14 days.
5) After use of cooling pipes to cool concrete is complete, fill pipes with grout.
a) Flowable non-shrink cement grout with minimum specified 28-day compressive strength not less than that of the surrounding concrete.

2. Temperature monitoring program:
a. Temperature monitoring and recording system:
1) Consist of temperature sensors connected to data acquisition system capable of printing, storing, and downloading data to computer.
2) Locate temperature sensors so that maximum temperature difference within mass concrete element can be monitored.
3) As minimum, monitor concrete temperatures at calculated hottest location, on at least 2 outer faces, and top surface.
4) Print and submit temperature data to the Engineer daily.

b. Temperature control period:
1) Maintain temperature control measures until the following requirements are met:
a) Maximum internal concrete temperature has been reached and temperature is falling.
b) Difference between interior concrete temperature and the average daily air temperature is less than allowable temperature difference for 3 consecutive days.

c) 5 days have elapsed since concrete was placed.
d) There are no adjacent mass concrete elements to be cast.

2) Monitor concrete temperatures during the temperature control period.
3) Do not place adjacent concrete placements during the temperature control period.

c. Concrete consolidation:
1) Use methods that prevent damage to temperature monitoring and recording system.

d. Temperature sensor and wiring:
1) Protect wiring connected to temperature sensors cast into concrete to prevent movement.
2) Keep wire runs as short as possible.
3) Do not allow ends of temperature sensors to come into contact with supports concrete forms or reinforcing bars.

e. Equipment failure:
1) When any equipment used in temperature control, monitoring, and recording system fails during concrete construction operation, take immediate measures to correct situation in accordance with the thermal control plan.
2) Failure to conform to temperature requirements will be cause for rejection of concrete.

2.02 MATERIALS

A. Concrete admixtures:
1. Air entraining admixture:
a. As specified in Section 03300 - Cast-in-Place Concrete.
2. Retarding admixture:
a. Set retarding admixture may be used to control set time and minimize premature setting of concrete and formation of cold joints.
b. As specified in Section 03300 - Cast-in-Place Concrete.
3. Water reducing admixture:
a. As specified in Section 03300 - Cast-in-Place Concrete.
4. Accelerating admixtures:
a. Do not use.

B. Aggregates:
1. As specified in Section 03300 - Cast-in-Place Concrete.

C. Portland cement:
1. Type II low alkali: As specified in Section 03300 - Cast-in-Place Concrete.
2. Do not use Type III in accordance with ASTM C150.

D. Fly ash:
1. As specified in Section 03300 - Cast-in-Place Concrete.

E. Concrete insulating blankets:
1. Commercially available, with R-value required in the thermal control plan.

F. Water and ice:
1. Mixing water: As specified in Section 03300 - Cast-in-Place Concrete.

2. Water for making ice: Meet requirements of mixing water as specified in Section 03300 - Cast-in-Place Concrete.
3. Ice may be substituted for mixing water on 1-to-1 ratio based on weight.

2.03 TEMPERATURE MONITORING SYSTEM

A. Manufacturers: One of the following or equal:
   1. FLIR Systems, Inc., Engius IntelliRock II System.
   2. The Transtec Group, Inc., Command Center.

B. Temperature logger:
   1. Consist of temperature sensor, microprocessor, and battery encased in polyester resin for protection.
   2. Calculate and store temperature readings of concrete.
   3. Maximum wire length in concrete: 50 feet.
   4. Capable of logging temperature hourly for 28 days.

C. Handheld reader:
   1. Use to communicate with and collect data from temperature loggers embedded in concrete.
   2. Use to instruct loggers to begin reading, download data from loggers, and upload logger data to computer.
   3. Logger data storage: 999 logger downloads.

D. Software:
   1. Use system software to transfer data from handheld reader to computer in secure, unalterable, electronic files.

2.04 MIXES

A. As specified in Section 03300 - Cast-in-Place Concrete for Class M concrete.

PART 3 EXECUTION

3.01 INSTALLATION

A. Concrete placement:
   1. As specified in Section 03300 - Cast-in-Place Concrete, except as modified in this Section.
   2. Preheat previously placed adjacent concrete to temperature above freezing.
   3. Do not place non-mass concrete with mass concrete.
   4. Do not place non-mass concrete until after thermal control period for adjoining mass concrete is complete.

B. Curing concrete:
   1. Water cure or plastic membrane cure as specified in Section 03300 - Cast-in-Place Concrete as soon as possible following placement of concrete.
      a. If water curing is used, use methods that minimize differential temperature between curing water and concrete.
      b. Consider type of curing in the thermal control plan.

C. Insulation:
   1. If insulation is required by the thermal control plan, install insulation on the following during the thermal control period:
      a. Formed surfaces.
      b. Finished surface such as top of slabs.
      c. Temporary surfaces such as construction joints.
      d. Reinforcing bars protruding from concrete placements.
      e. Steel braces and catwalk supports attached to formwork.
      f. Pipes protruding from concrete placement.
      g. Conduits protruding from concrete placement.
      h. Minimum of 3 feet past concrete placement onto previously placed adjacent concrete.
      i. Other items protruding from concrete that would contribute to heat loss from concrete.
   2. Install insulation blankets on complete area of formwork that extends past concrete placement.
      a. Install insulation blankets tightly against formwork to prevent air movement between insulating blankets and forms.
      b. Install insulation on formwork before placing mass concrete.
   3. Install insulation on finished surfaces when:
      a. Finishing is complete.
      b. Concrete has sufficient strength to prevent damage due to installation of insulation.
      c. Before excessive temperature differential develops.
   4. Protruding reinforcing bars, conduits, and pipes:
      a. For 1-inch diameter, or minimum dimension, and smaller, insulate for minimum of 3 feet from face of concrete placement.
      b. For diameter, or minimum dimension, greater than 1 inch, insulate for minimum of 6 feet from face of concrete placement.
      c. Use insulation with R-value equal to or greater than required for adjacent surface of concrete placement.
      d. Install insulation before placing mass concrete.
   5. Insulation shall remain in place until end of the thermal control period.

D. Cold weather concreting:
   1. As specified in Section 03300 - Cast-in-Place Concrete, except do not use steam or other concrete heating methods that will increase concrete temperature outside range as specified in this Section.

E. Hot weather concreting:
   1. As specified in Section 03300 - Cast-in-Place Concrete.
   2. Use fog sprayers to reduce ambient air temperature and increase humidity during concrete placement.

3.02 FIELD QUALITY CONTROL

A. Temperature monitoring program:
   1. Use temperature monitoring system to measure concrete temperatures in interior and near surface of concrete.
   2. Continuously monitor temperature of the interior of the concrete and surfaces of concrete during cooling period.

3. Temperature monitoring data not conforming to requirements of this Section:
    a. Stop placing concrete.
    b. Concrete not conforming to temperature requirements of this Section will be rejected. Remove rejected concrete at the Contractor's expense.
    c. Modify the thermal control plan and calculations to correct problem and resubmit.
    d. Do not place concrete until revised thermal control plan and calculations have been submitted and accepted by the Engineer.

B. Concrete placement temperatures:
    1. Measure and record concrete temperature at point of placement.

END OF SECTION

SECTION 03922

PREPACKAGED SMALL AGGREGATE REPAIR CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Prepackaged concrete for the repair of concrete.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C33 - Standard Specification for Concrete Aggregates.
   2. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   3. C150 - Standard Specification for Portland Cement.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

C. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components.

1.03 SUBMITTALS

A. Product data.

B. Manufacturer's instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store in unopened containers in clean, dry area with temperature between 45 and 90 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 PREPACKAGED CONCRETE

A. Coarse aggregate: Maximum 3/8-inch aggregate in accordance with ASTM C33.

B. Portland cement: Type I or II in accordance with ASTM C150.

C. Compressive strength: 5,000 pounds per square inch at 28 days minimum, in accordance with ASTM C39.

D. Packaged in multi-wall bags.

E. Manufacturers: One of the following or equal:
   1. Master Builders Solutions/Sika

PART 3 EXECUTION

3.01 PREPARATION

A. In accordance with manufacturer's written instructions. If manufacturer's instructions are not available, prepare as indicated:
   1. Clean the entire slab surface as required to remove dirt, oil, curing compound, laitance, dust, and other matter that may prevent proper grout bonding.
   2. Concrete substrate shall have rough texture, suitable for bonding repair concrete.
   3. Roughen concrete substrate in contact with repair concrete to ICRI Guideline No. 310.2R, CSP-6 surface profile or rougher using method suitable to the Engineer.
      a. Remove loose or broken concrete.
   4. Saturate concrete substrate with potable water for minimum of 3 days just before placing repair concrete. At the time repair concrete is placed, substrate shall be saturated and surface damp with no standing water.

3.02 INSTALLATION

A. Slump range: 4 to 6 inches.

B. Mix in accordance with manufacturer’s instructions.

C. Water for mixing: As specified in Section 03300 - Cast-in-Place Concrete.

D. Water cure concrete repair area as specified in Section 03300 - Cast-in-Place Concrete.

END OF SECTION

SECTION 03926

STRUCTURAL CONCRETE REPAIR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Repairing damaged structural concrete.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
   2. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
   3. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars).
   4. C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   5. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

1.03 SUBMITTALS

A. Product data: Submit manufacturer's data completely describing structural repair concrete materials.

B. Certificates of Compliance.

C. Manufacturer's instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: The manufacturer of the specified product shall have been in existence for a minimum of 10 years.

B. Allowable tolerances: Deviation from plumb or level shall not exceed 1/8 inch within 10 feet in any direction, as determined with a 10-foot straight edge.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the manufacturer.

C. Deliver, store, and handle packaged materials in the manufacturer's original, sealed containers, each clearly identified with the manufacturer's name, and name and type of product.

D. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground, and suitably protected.

1.06 PROJECT CONDITIONS

A. Existing conditions:
   1. Hot weather: ACI 305.
   2. Cold weather: ACI 306.
   3. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. General: Structural repair concrete composed of cementitious material capable of being placed in formed vertical and overhead applications, and on horizontal surfaces.

B. Design requirements:
   1. Provide material suitable for performing in environments subject to corrosive attack by chlorides and sulfates, freeze/thaw cycles, low permeability, and abrasion resistant.
   2. Provide concrete repair mortar cement that is placeable from 1 inch in depth and extendable in greater depths.
   3. Concrete repair mortar shall be capable of being poured in place or troweled in place to suit the conditions encountered.

2.02 MATERIALS

A. Structural repair concrete:
   1. Manufacturers: One of the following or equal:
      a. Master Builder Solutions/Sika, MasterEmaco S 466CI.
      b. Sika Corp., SikaTop 123 Plus.
   2. Compressive strength: As follows in accordance with ASTM C109:
      a. 1 day: 2,500 pounds per square inch, minimum.
      b. 7 days: 6,000 pounds per square inch, minimum.
      c. 28 days: 7,000 pounds per square inch, minimum.
   3. Bond strength by slant shear: 2,200 pounds per square inch minimum at 28 days, in accordance with ASTM C882 modified.
   4. Flexural strength: 2,000 pounds per square inch minimum at 28 days, when tested in accordance with ASTM C293, or 770 pounds per square inch minimum at 28 days when tested in accordance with ASTM C348.
   5. Rapid freeze/thaw durability: In accordance with ASTM C666; Procedure A.
      a. Relative durability factor at 300 cycles: 95 percent minimum.
   6. Working time: 30 to 40 minutes.

7. Color: Concrete gray.

B. Water: Potable, clean, not detrimental to concrete.

C. Form materials:
   1. Smooth finish.
   2. Brace as required to maintain tolerances.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete surfaces and exposed reinforcing are clean and free of contaminants.

3.02 PREPARATION

A. Prepare existing concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. Thoroughly clean reinforcement and other embedded items to remove loose rust and other objectionable matter.

C. Thoroughly wet wood forms, except coated plywood, and adjacent concrete at least 1 hour in advance of placing concrete; securely close cleanout end inspection ports; repeat wetting as necessary to keep forms damp.

D. Damaged concrete:
   1. Areas to be repaired shall be clean, sound, and free of contaminants.
      a. Remove loose and deteriorated concrete by mechanical means acceptable to the Engineer.
      b. Saw cut perimeter 1/2-inch maximum.
   2. Chip concrete substrate to obtain a surface profile of 1/16 inch to 1/8 inch in depth with a new fractured aggregate surface.
      a. Area to be repaired shall be not less than 1 inch in depth.
   3. Concrete removal shall extend along the reinforcing steel to locations along the bar free of bond inhibiting corrosion, and where the bar is well bonded to surrounding concrete.

E. Use the following procedures where reinforcing steel with active corrosion is encountered:
   1. Sandblast reinforcing steel to remove contaminants and rust.
   2. Determine section loss, splice new reinforcing steel where there is more than 15 percent loss as directed by the Engineer.
      a. If more than half the diameter of the reinforcing steel is exposed, chip out behind the reinforcing steel a minimum of 1/2 inch. Distance chipped behind the reinforcing steel must also equal or exceed the minimum placement depth of the accepted material.

F. Treat cracks in the substrate at the area of patching or overlay work as directed by the Engineer.

G. Extend existing control and expansion joints through any concrete repair.

H. Apply an epoxy-bonding agent to area to be repaired, as specified in Section 03071 - Epoxies, prior to patching concrete with polymer-modified Portland cement mortar.

3.03 MIXING

A. Mix in accordance with manufacturer's mixing instructions.

3.04 INSTALLATION

A. Formed surface finishes:
   1. Smooth finish:
      a. Obtain by the use of plywood, sheet metal, or lined wood forms; no fins, pockmarks, or other irregularities shall be present in the exposed surfaces of concrete.
      b. Place no structural repair concrete without prior authorization of the Engineer.

B. Verify that form materials are in place and ready to receive installation of concrete repair material.

C. Install in accordance with manufacturer's installation instructions.

D. In accordance with ACI recommendations, apply concrete repair material only when ambient conditions of moisture, temperature, humidity, and wind are favorable for curing.

E. Scrub mortar into substrate, filling cracks, voids, and pores.

F. For new construction, the finish of repaired area shall match required finish for concrete being repaired.

G. For existing concrete, finish of repair area shall match finish of concrete being repaired.

H. During the curing process, protect concrete repair from rain, wind, or freezing as required:
   1. Keep sufficient covering on hand at all times for protection of repair concrete.

3.05 CLEANING

A. Remove debris and excess material. Leave work site in a neat, clean condition.

END OF SECTION

SECTION 03931

EPOXY INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Test Method for Epoxy-Resin-Base Bonding Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   5. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer's data completely describing epoxy injection system materials and including test methods and results for strength in tension, flexure, compression and bond; flexural modulus of elasticity; coefficient of thermal expansion; and elongation.
   2. Data demonstrating that products are listed under NSF-61 for use in direct contact with potable water.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

D. Special procedure submittals:
   1. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair, with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.
      e. Testing and inspection procedures.
      f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall include product identification, batch numbers, and shelf life information.

B. Store materials off the ground and away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before mixing and using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Repair materials shall be free of chlorides or alkalis (except for those attributed to water).
   2. To ensure compatibility of materials and methods, a single manufacturer shall produce and provide all products used together in a single area of concrete repair.
   3. Listed under NSF-61 for use in direct contact with potable water.

B. Manufacturers: One of the following, or equal:
   1. Sika Chemical Corp., Sikadur 35 Hi-Mod LV.

C. Epoxy:
   1. In accordance with ASTM C881, Types I, II and IV, Grade 1, Class C.
   2. Water-insensitive 2-component low viscosity, epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Table 1. Epoxy, Physical Properties

Characteristic	Test Method	Required Results, minimum[(1),(2)]
Viscosity (mixed)	--	250 to 375 centipoise
Tensile Strength	ASTM D638	7,500 pounds per square inch
Tensile Elongation at Break	ASTM D638	1 percent
Compressive Strength	ASTM D695	11,000 pounds per square inch
Compressive Modulus	ASTM D695	2.5×10^5 pounds per square inch
Bond Strength, slant shear, hardened concrete to hardened concrete	ASTM C882	1,500 pounds per square inch at 2 days at minimum 73 degrees Fahrenheit. Concrete shall fail before failure of epoxy.
Heat Deflection Temperature	ASTM D648	124 degrees Fahrenheit

Notes:
(1) Properties for mixes with neat epoxy.
(2) Results after 7-day cure at temperature between 72 and 78 degrees Fahrenheit, unless otherwise noted.

2.02 EQUIPMENT

A. Injection pump:
   1. Use positive displacement injection pump with interlock to provide in-line mixing and metering system for 2 component epoxy.
   2. Use pressure hoses and injection nozzle designed to properly mix of 2 components of epoxy.
   3. Standby injection unit may be required.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperature and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing epoxy injection.
   2. Sweep or clean area in vicinity of cracks that will be injected with epoxy. Leave area in generally clean condition after epoxy injection is complete.
   3. Clean cracks so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix epoxy in accordance with manufacturer's installation instructions.
   2. Do not use solvents to thin epoxy system materials introduced into cracks or joints.

C. Injection:
   1. Apply adequate surface seal to crack to prevent leakage of epoxy.
   2. Establish injection points at distance along crack not less than thickness of cracked member.
   3. Crack injection sequence:
      a. Inject epoxy into crack or joint at first port with sufficient pressure to advance epoxy to adjacent port. Start at lowest port along the injection line and work upwards.
      b. Seal original port and shift injection to next adjacent port where epoxy appears.
      c. Continue port-to-port injection until crack has been injected for its entire length.
      d. For small amounts of epoxy, or where excessive pressure developed by injection pump might further damage structure, premixed epoxy and use hand caulking gun to inject epoxy if acceptable to the Engineer.
      e. Seal ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out.
      f. After epoxy injection is complete, remove surface seal material, and refinish concrete in area where epoxy was injected to match existing concrete. Leave finished work and work area in a neat, clean condition.

3.03 FIELD QUALITY ASSURANCE

A. Provide Contractor quality control as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
   1. Submit records of inspections and tests to Engineer within 24 hours after completion.

C. Manufacturer's services.
   1. Pre-installation meeting: Provide manufacturer's technical representative to attend pre-installation meeting specified in this Section.

3.04 FIELD QUALITY CONTROL

A. Provide Owner's quality assurance for the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections special tests, and structural observation:
   1. Not required.

C. Field inspections:
   1. Preparation.
      a. Review manufacturer's product data and installation instructions.
   2. Required inspections.
      a. Observe surfaces to be injected for temperature and moisture conditions and for surface preparation.
      b. Observe conditioning and mixing of epoxy resin components.
      c. Observe injection procedures for filling cracks.
   3. Records of inspections:
      a. Provide a record of each inspection.
      b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Rework surface finishes that do not match surrounding concrete to the satisfaction of the Engineer at no additional cost to the Owner.

END OF SECTION

SECTION 03933

HYDROPHILIC AND HYDROPHOBIC FOAM POLYURETHANE RESIN INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Hydrophilic and hydrophobic foam polyurethane resin injection systems.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D3574 - Standard Test Methods for Flexible Cellular Materials-Slab, Bonded, and Molded Urethane Foams.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: Submit manufacturer's data completely describing polyurethane resin injection system materials.

C. Quality control Submittals:
   1. Certificates of Compliance.
   2. Manufacturer's instructions.
   3. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by the manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.
      e. Testing and inspection procedures.
      f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall indicate product identification, batch numbers, and shelf life.

B. Store materials off the ground, away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Polyurethane resin injection systems that will be in direct contact with water after the Work is completed shall comply with applicable federal, state, or local regulations.
      a. Confirm compliance by submitting documentation that products have been tested and listed in accordance with NSF-61 requirements. Provide testing by a nationally-recognized agency acceptable to Engineer.
   2. Repair materials shall be free of chlorides or alkalis (except for those attributed to water).
   3. To ensure compatibility of materials and methods, a single manufacturer shall produce and provide all products used together in a single area of concrete repair.

B. Manufacturers: One of the following, or equal:
   1. Master Builders Solutions/Sika, MasterInject 1210 IUG (formerly Concresive 1210 IUG).
   2. Sika Corp., SikaFix HH LV.

C. Resin:
   1. Water-insensitive 1-part low-viscosity polyurethane resin adhesive material containing 100-percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Physical Characteristic	**Required Results**
Viscosity	400 to 600 CPS at 70 degrees Fahrenheit
Flash Point	Greater than 200 degrees Fahrenheit
Corrosiveness	Non-corrosive
Reaction Time	75 to 90 seconds at 80 degrees Fahrenheit
Toxicity	Non-toxic

a. Uncured.
b. Cured foam (1:1):

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D3574 ASTM D638	150 to 400 pounds per square inch 29 pounds per square inch
Elongation	ASTM D3574 ASTM D638	400 to 1,200 percent 44 percent

2.02 EQUIPMENT

A. Pump unit:
   1. Furnish unit to be used for injection that is positive displacement type with interlock to provide in-line mixing and metering system for 1 component polyurethane resin.
   2. Furnish pressure hoses and injection nozzle of such design as to allow proper mixing of polyurethane resin.
   3. Standby injection unit may be required.

B. Resin pump: Operating pressure in excess of 2,000 pounds per square inch with a variable pressure control trigger mechanism with attached pressure gauge, on the downstream end of the material supply hose.

C. Water pump: High-pressure water blaster capable of 1,000 pounds per square inch or higher pressure.

D. Incidentals: To be determined by site conditions and Contractor. See Installation Bulletin 6I12 - Urethane Injection, from Master Builders Solutions Construction Chemicals, LLC.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperatures and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing urethane injection.
   2. Sweep or clean area in vicinity of cracks and joints that will be injected with polyurethane resin.
   3. Clean cracks and joints so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure polyurethane resin materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix urethane in accordance with manufacturer's installation instructions.

C. Injection:
   1. Apply adequate surface seal to crack or joint to prevent escape of polyurethane resin.
   2. Establish injection ports along seal at a spacing not greater than the thickness of cracked member.
   3. Inject polyurethane resin into crack or joint at first port with sufficient pressure to advance polyurethane resin to adjacent port. Start at lowest port along the injection line and work upwards.
      a. Seal original port and shift injection to next adjacent port at which polyurethane resin appears.
      b. Continue port-to-port injection until each crack or joint has been injected for its entire length.
   4. For small amounts of polyurethane, or where excessive pressures developed by injection pump unit might further damage the structure, material mixed and installed with a hand caulking gun may be used if acceptable to the Engineer.
   5. Seal ports, including adjacent locations where polyurethane resin seepage occurs, as necessary to prevent drips or run out.
   6. After injection is complete, remove surface seal material and re-finish concrete in the area where the polyurethane was injected to match surrounding concrete. Leave finished work and work area in a neat and clean condition.

3.03 FIELD QUALITY CONTROL

A. Provide Contractor quality control as specified in Section 01450 - Quality Control.

B. Field inspections and tests:
   1. Submit records of inspections and test to Engineer within 24 hours after completion.

C. Manufacturer's services.
   1. Pre-installation meeting: Provide manufacturer's technical representative to attend pre-installation meeting specified in Section 01450 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide Owner quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Not required.

C. Field inspections:
   1. Preparation.
      a. Review manufacturer's product data and installation instructions.
   2. Required inspections:
      a. Observe surfaces to be injected for temperature and moisture conditions.
      b. Observe conditioning and preparation of urethane resin.
      c. Observe injection procedures for filling cracks.

3. Records of inspections:
    a. Provide record of each inspection.
    b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Cracks, after injection, shall show no evidence of running or seeping water. Re-inject as necessary to provide watertight seal at no additional cost to Owner.

B. Rework surface finishes that do not match surrounding concrete to the satisfaction of the Engineer at no additional cost to Owner.

END OF SECTION

SECTION 04055

ADHESIVE BONDING REINFORCING BARS AND ALL THREAD RODS IN MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in masonry using injectable, 2-component adhesive.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

B. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC58 - Acceptance Criteria for Adhesive Anchors in Masonry Elements.

C. Society for Protective Coatings (SSPC):
   1. Surface Preparation Standards (SP).
      a. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

A. Evaluation Report: Report prepared by ICC-ES, or by other testing agency acceptable to the Engineer and to the Authority Having Jurisdiction, that documents testing and review of the adhesive product to confirm that it conforms to the requirements of ICC-ES AC58.

1.04 SUBMITTALS

A. Product data: Furnish technical data for adhesives, including:
   1. Independent testing laboratory results indicating allowable loads in tension and shear for masonry walls of the types included in the Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
   2. Handling and storage instructions.
   3. Installation instructions.

B. Quality control submittals:
   1. Special inspection: Detailed instructions for special inspection to comply with the building code specified in Section 01410 - Regulatory Requirements.
   2. Evaluation Report confirming that the product complies with the requirements of ICC-ES AC58.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store and protect as follows, unless manufacturer has more stringent requirements:
   1. Store adhesive components on pallets or shelving in a covered storage area protected from weather.
   2. Control temperature to maintain storage within manufacturer's recommended temperature range.
      a. If products are stored at temperatures outside manufacturer's recommended range, test components prior to use by methods acceptable to the Engineer to determine if the products still meet specified requirements.
   3. Dispose of products that have passed their expiration date.

1.06 PROJECT CONDITIONS

A. As specified in Section 01850 - Design Criteria.

B. Seismic design category (SDC) for structures: As specified in Section 01850 - Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer to achieve structural compatibility and single-source responsibility.

2.02 ADHESIVE FOR SELF-CONTAINED CARTRIDGE SYSTEM

A. Adhesive shall have a current Evaluation Report demonstrating compliance with the requirements of ICC-ES AC58.

B. Materials:
   1. 2-component structural adhesive, insensitive to moisture, and gray in color.
   2. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

C. Packaging:
   1. Furnished in disposable, side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
      a. Nozzle designed to thoroughly blend the components, in the proper mixing ratio, for injection from the nozzle directly into prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filling from the bottom of the hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

D. For installation in solid masonry and solid-grouted masonry (concrete or brick):
   1. Manufacturers: One of the following or equal:
      a. Hilti, Inc., HY-270 Adhesive Anchor System.
      b. Simpson Strong-Tie Co., Inc., ET-HP Anchoring Adhesive.
      c. USP Structural Connectors, CIA-GEL 7000 Masonry Epoxy Adhesive.

2.03 ALL THREAD RODS

A. Materials: As specified in Section 05120 - Structural Steel Framing.

2.04 REINFORCING BARS

A. As specified in Section 04090 - Masonry Accessories.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise required for “conditions of use” in the Evaluation Report submitted, prepare and install holes, adhesive, and inserts (all thread rods or reinforcing bars) in accordance with the manufacturer’s recommendations and this Section.
   1. In the event of conflicts, the more restrictive provisions shall govern.

B. Do not install adhesive-bonded all-thread rods or reinforcing bars in upwardly inclined and overhead applications.

3.02 PREPARATION

A. Prior to completing manufacturer’s on-site training specified in this Section, do not:
   1. Drill holes for reinforcing bars or all thread rods.
   2. Mix or install adhesive in holes.

B. Review manufacturer’s installation instructions and “conditions of use” stipulated in the Evaluation Report before beginning work.

C. Confirm that adhesive and substrate receiving adhesive are within manufacturer’s recommended temperature range and will remain so during the cure time for the product.

3.03 HOLE LAYOUT AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device. Mark locations with on the surface of the masonry using removable construction crayon, or other method acceptable to the Engineer.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the masonry without prior acceptance by Engineer.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type.
      a. Set drill to “rotation only” mode, or to “rotation plus hammer” mode in accordance with manufacturer’s installation instructions and the requirements of the Evaluation Report.
   2. Where edge distances are less than 2 inches and “rotation plus hammer” mode is permitted, use lighter impact equipment to prevent micro-cracking and spalling from drilling.
   3. Drill bits: Carbide-tipped in accordance with ANSI B212-15.
   4. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer’s installation instructions and the Evaluation Report.

D. Hole depth: As recommended by the manufacturer’s installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill to the required depth.
      a. Allow dry-pack mortar to cure to strength equal to that of the surrounding masonry before resuming drilling in that area.
      b. Epoxy grout may be substituted for dry-pack mortar when acceptable to the Engineer.
   2. Avoid drilling an excessive number of adjacent holes that would weaken the structural member and endanger the stability of the structure. Obtain Engineer’s acceptance of distance between abandoned and relocated holes.
   3. When existing reinforcing steel is encountered during drilling and when acceptable to Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter.
   4. Bent bar reinforcing bars: Where edge distances are critical and interference with existing reinforcing steel is likely, and if acceptable to Engineer, drill hole at 10 degree angle (or less) from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
   1. Insert air nozzle to bottom of hole and blow out loose dust.
      a. Use compressed air that is free of oil, water, or other contaminants.
      b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
   2. Using a stiff bristle brush of diameter that provides contact around the full perimeter of the hole, vigorously brush the hole to dislodge compacted drilling dust.
      a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
      b. Repeat at least 4 times.

3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and as required by the manufacturer and the Evaluation Report.
4. Leave prepared hole clean and dry.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. The inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
   2. Solvent-clean prepared reinforcing bars and all thread rods over their embedment length in accordance with SSPC SP-1. Provide an oil and grease-free surface for bonding of adhesive to steel.

B. Fill holes with adhesive: Solid or solid-grouted masonry:
   1. Starting at the bottom of the hole, fill hole with adhesive before inserting the reinforcing bar or all thread rod.
   2. Fill hole without creating air voids as nozzle is withdrawn.
   3. Fill hole with sufficient adhesive so that excess is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole.
   4. Where metal or plastic screens are required for use in masonry (units with hollow cells or holes, and multi-wythe brick walls), fill screen with adhesive and insert into hole in accordance with manufacturer’s recommendations.

C. Install reinforcing bars and all thread rods:
   1. Install to depth, spacing, and locations as indicated on the Drawings.
   2. Insert bars and all thread rods into hole in accordance with manufacturer’s recommended procedures. Confirm that insert has reached the designated embedment in the hole and that adhesive completely surrounds the embedded portion.
   3. Clean excess adhesive from the mouth of the hole.

D. Curing and loading:
   1. Provide curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the actual temperature of the masonry.
   2. Do not disturb or load anchors until manufacturer’s recommended cure time has elapsed.

3.05 FIELD QUALITY CONTROL

A. Contractor shall provide field quality control as specified in Section 01450 - Quality Control.

B. Manufacturers' services:
   1. Before beginning installation, furnish adhesive manufacturer's representative to conduct on-site training in proper storage and handling of adhesive, drilling

and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
    a. Provide notice of training to Engineer and Special Inspector not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
2. Submit record, signed by the Engineer, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.
3. Do not install holes or adhesive until training is complete.

3.06 FIELD QUALITY ASSURANCE

A. **CONTRACTOR** will provide on-site inspection and field quality assurance.

B. Special inspection:
1. As specified in Section 01455 - Regulatory Quality Assurance.
2. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the "Conditions of Use" in the Evaluation Report for the product installed.
    a. Provide continuous inspection of placement of adhesive and insertion of reinforcing bars and all thread rods into adhesive.
3. Provide a written record of each inspection using form acceptable to the Engineer and the Authority Having Jurisdiction.
4. Preparation:
    a. Review drawings and specifications for the Work being observed.
    b. Review adhesive manufacturer's recommended installation and evaluation report's special inspection procedures.
5. Provide an initial inspection by for each combination of masonry type and reinforcing bar or all thread rod being installed. During initial inspection, observe the following for compliance with installation requirements. Furnish report of inspection that includes the following items.
    a. Masonry construction: Type and thickness; whether fully or partially grouted; locations and types of voids and holes in units.
    b. Environment: Temperature and moisture conditions of masonry base material and work area.
    c. Holes: Locations, spacing, edge distances; verification of drill bit compliance with ANSI B212.15; cleaning equipment and procedures; cleanliness of hole. Before placing adhesive, confirm that depth and preparation of holes conforms to requirements of the Contract Documents, installation recommendations of the manufacturer, and "conditions of use" specified in the Evaluation Report.
    d. Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedures. Note initial set times observed during installation.
    e. Embedded reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment.

6. Subsequent installations of the same reinforcing bars or threaded rods in the same masonry may be performed without the presence of the special inspector, provided that:
    a. There is no change in the personnel performing the installation, the type or details of the masonry receiving the insert, the adhesive or the reinforcing bars and all thread rods being used. Changes in any of these items shall require a new initial inspection.
    b. For ongoing installations over a period of time, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.

END OF SECTION

SECTION 04090

MASONRY ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Adjustable veneer joint reinforcement.
   2. Adjustable veneer ties.
   3. Control joint key.
   4. Foamed-in place insulation.
   5. Loose fill insulation.
   6. Reinforcing bars.
   7. Sheet metal ties.
   8. Wall tie screws.
   9. Wire joint reinforcement, single Wythe type.
   10. Weep holes.

1.02 REFERENCES

A. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

B. ASTM International (ASTM):
   1. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   2. A951 - Standard Specification for Masonry Joint Reinforcement.
   3. A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   4. C549 - Standard Specification for Perlite Loose Fill Insulation.
   5. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   6. D2287 - Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures and Section 01600 - Product Requirements.

B. Reinforcing bars:
   1. Changes to reinforcing steel Contract Drawing requirements:
      a. Indicate in separate letter submitted with Shop Drawings any changes of requirements indicated on the Drawings for reinforcing steel.
      b. Such changes will not be acceptable unless the Engineer has accepted such changes in writing.

c. Reinforcement detail drawings:
   1) Review of reinforcement Shop Drawings by the Engineer will be limited to general compliance with the Contract Documents.
d. Welding procedures.

C. Product data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

B. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

PART 2 PRODUCTS

2.01 GENERAL

A. Drawings contain notes concerning amount of reinforcement and placing, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in masonry.

2.02 MANUFACTURED UNITS

A. Adjustable veneer joint reinforcement: Ladder-type steel joint reinforcement with minimum W2.8 (3/16-inch diameter) size longitudinal wires, W2.8 (3/16-inch diameter) size cross wires spaced at a maximum distance of 16 inches on-center, and 2 or more eyes formed of minimum W2.8 (3/16-inch diameter) wire welded to joint reinforcement capable of resisting a minimum strength design load of 335 pounds (or allowable load of 200 lbs.). Maximum cavity width of 6 inches.
   1. Manufacturers: One of the following or equal (stainless steel 316):
      a. Hohmann & Barnard, 270-2X Ladder Eye-Wire.
      b. Wire-Bond, Series 800 Ladder Level-Eye.
      c. Heckmann Building Products, #1300: Ladder Pintle Eye Wire Reinforcement.

B. Adjustable veneer ties: two or more steel pintle legs of minimum W2.8 (3/16-inch diameter) wire with a maximum distance of 2 inches from inside face of veneer to end of adjustable part, detailed to prevent disengagement and resist a minimum strength design load of 335 pounds (or allowable load of 200 pounds) have a vertical wire offset not exceeding 1.25 inches , and embedded in the veneer to a W2.8 (3/16-inch diameter) continuous wire.
   1. Manufacturers: One of the following or equal (stainless steel 316):
      a. Hohmann & Barnard, 2X-HOOK SH-Seismic Hook with Continuous Wire.
      b. Wire-Bond, Series 800, #0193 & #3500: Seismic Hook with Metal Clip and Continuous Wire.
      c. Heckmann Building Products, #263 & #371: Double Pintle Tie and Continuous Wire.

C. Anchor bolts:
   1. Cast-in/built-in steel anchors: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Includes anchor bolts, anchor rods, deformed bar anchors, and welded studs.
   2. Post-installed steel anchors: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Includes concrete anchors for concrete masonry, and screw anchors for concrete masonry.

D. Control joint key: Key of the width and shape as indicated on the Drawings.
   1. PVC in accordance with ASTM D2000 or ASTM D2287.
   2. Manufacturers: One of the following or equal:
      a. Hohmann & Barnard, VS Standard.
      b. Southern Metals and Plastics, No. CJ1.
      c. Wire-Bond, No. 2901.

E. Loose fill insulation:
   1. Perlite: In accordance with ASTM C549, Type IV, surface-treated for water repellency and to limit dust generation during installation.

F. Foamed-in-place masonry insulation:
   1. Manufacturers: The following or equal:
      a. Tailored Chemical Products, Core-Fill 500™.

G. Reinforcing bars:
   1. Deformed bars in accordance with ASTM A615, Grade 60.
   2. Provide reinforcing steel that is of quality specified, free from excessive rust or scale or any defects affecting its usefulness.

H. Sheet metal ties: Minimum 22 gauge corrosion resistant corrugated sheet metal, minimum 7/8 inch wide by 7 inches long, pre-punched for wire ties to wire joint reinforcement.

I. Wall tie screws.

J. Weep holes: 3/8 inch cellular drainage structure to fit in head joint of veneer units to promote drainage of the air space cavity.
   1. Manufacturers: One of the following or equal:
      a. Hohmann & Barnard, Quadro-Vent.
      b. Wire-Bond, #3601 Cell-Vent.
   2. Manufactured of ultraviolet-light resistant polypropylene cellular 3/8 inch thick.
   3. Color selected from manufacturer’s standard colors to most closely match the selected mortar color.
   4. Size shall match the depth and height of the veneer units selected.

2.03 FABRICATION

A. Reinforcing bars:
   1. Cut and bend bars in accordance with the building code specified in Section 01410 - Regulatory Requirements.

2. Bend bars cold.
3. Provide bars free from defects, kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Reinforcing bars:
   1. Verify that bars are new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the Work.

3.02 PREPARATION

A. Reinforcing bars:
   1. Thoroughly clean any bars that have rust scale, loose mill scale, or thick rust coat.
      a. Thin coating of red rust resulting from short exposure will not be considered objectionable.
   2. Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent masonry placement.

3.03 INSTALLATION

A. Reinforcing bars:
   1. No field bending of bars will be allowed.
   2. Welding:
      a. Weld reinforcing bars where indicated on the Drawings or acceptable to the Engineer.
      b. Perform welding in accordance with AWS D1.4.
      c. Do not tack weld reinforcing bars.

B. Placing reinforcing bars:
   1. Accurately place bars and adequately secure them in position.
   2. Overlap bars at splices as indicated on the Drawings or specified.
   3. If not indicated on the Drawings, lap splice bars in masonry in accordance with the building code specified in Section 01410 - Regulatory Requirements.

END OF SECTION

SECTION 04100

MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Mortar and grout for masonry construction.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C144 - Standard Specification for Aggregate for Masonry Mortar.
   2. C150 - Standard Specification for Portland Cement.
   3. C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
   4. C270 - Standard Specification for Mortar for Unit Masonry.
   5. C404 - Standard Specification for Aggregates for Masonry Grout.
   6. C476 - Standard Specification for Grout for Masonry.
   7. C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   8. C1019 - Standard Test Method for Sampling and Testing Grout.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

1.04 SUBMITTALS

A. Product data.

B. Shop Drawings.

C. Design mixes for mortar and grout.

D. Test reports:
   1. Mortar Strength Test Results.
   2. Grout Strength Test Results.

1.05 QUALITY ASSURANCE

A. Materials for mortar and grout: Do not change source of materials which will affect the appearance of finished work after the work has started unless acceptable to the Engineer.

1.06 PROJECT CONDITIONS

A. Environmental requirements:
   1. Cold weather requirements:
      a. Cold weather construction: In accordance with the building code as specified in Section 01410 - Regulatory Requirements.
      b. Provide adequate equipment for heating mortar and grout materials when air temperature is below 40 degrees Fahrenheit.
         1) Temperatures of separate materials, including water, shall not exceed 140 degrees Fahrenheit when placed in mixer.
         2) Maintain mortar temperature on boards above freezing.
   2. Hot weather requirements:
      a. Wet mortar board before loading and cover mortar to retard drying when not being used.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Compressive strength:
   1. Mortar: Minimum 2,000 pounds per square inch at 28 days.
   2. Grout: Minimum 2,000 pounds per square inch at 28 days.

2.02 MATERIALS

A. Portland cement:
   1. Type II, low alkali, containing maximum 0.6 percent total alkali in accordance with ASTM C150.

B. Hydrated lime:
   1. Type S in accordance with ASTM C207.

C. Aggregate for mortar:
   1. Fine aggregate: Sand in accordance with ASTM C144.

D. Aggregate for grout:
   1. Fine aggregate: Size Number 2 in accordance with ASTM C404.
   2. Coarse aggregate: Size Number 8 in accordance with ASTM C404.

E. Admixtures:
   1. Grout admixture:
      a. Manufacturers: The following or equal:
         1) Sika Corp., Sika Grout Aid, Type II.
   2. Mortar water repellent admixture:
      a. Manufacturers: One of the following, or equal:
         1) Master Builder Solutions/Sika, MasterPel 240MA.
         2) Sika Corp., Sikaproof A.
         3) W.R. Grace, Dry Block Mortar.
   3. Other admixtures:
      a. Prohibited, unless accepted by the Engineer.

F. Water: Clean, clear, potable, free of oil, soluble salts, chemicals, and other deleterious substances.

G. Other materials:
   1. Prohibited, unless acceptable to the Engineer.

2.03 MIXES

A. Mortar mix:
   1. Portland cement-lime mortar.
   2. Mortar mix proportions by volume: As indicated in the following table:

Mortar Type	Parts by Volume of Portland Cement	Parts by Volume of Hydrated Lime	Aggregate Measured in a Damp Loose Condition
S	1	Greater than 1/4 to 1/2	Not less than 2-1/4 and not more than 3 times the sum of the separate volumes of cementitious materials
N	1	Greater than 1/2 to 1-1/4	Not less than 2-1/4 and not more than 3 times the sum of the separate volumes of cementitious materials

   3. Mortar mixing:
      a. Mix on jobsite in accordance with ASTM C270.
      b. Mix in mechanical mixer and only in quantities needed for immediate use.
      c. Mix for minimum 3 minutes, and maximum of 5 minutes after materials have been added to mixer.
   4. Measurement by volume: Measurement of constituents shall be accomplished by the use of a container of known capacity.
   5. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units.
      a. Use no mortar which has been standing for more than 1 hour after being mixed.
   6. Whenever 90 minutes has elapsed since last batch was mixed, completely empty mixer drum of materials and wash down before placing next batch of materials.

B. Grout mix:
   1. Grout mix proportions by volume: As indicated in the following table:

Type of Grout	Parts by Volume of Portland Cement	Parts by Volume of Hydrated Lime	Aggregate Measured in a Damp Loose Condition	
			Fine Aggregate	Coarse Aggregate
Fine grout	1	0-1/10	2-1/4 to 3 times the sum of the volumes of the cementitious materials	-
Coarse grout	1	0-1/10	2-1/4 to 3 times the sum of the volumes of the cementitious materials	1 to 2 times the sum of the volumes of the cementitious materials

2. Grout mixing:
    a. Mix on jobsite or in a transit mix in accordance with ASTM C476
    b. Slump: 8 to 11 inches, unless otherwise accepted by the Engineer.
    c. Use within 90 minutes after addition of mixing water.
    d. Mix for minimum of 5 minutes after ingredients are added and until uniform mix is attained. Grout shall have sufficient water added to produce pouring consistency without segregation.
3. Use coarse grout for hollow cell masonry units with minimum 4-inch cell dimensions in both horizontal directions.
    a. Calculate cell dimension for this criterion by subtracting diameter(s) of any horizontal reinforcement crossing the cell from clear cell dimensions of the masonry unit.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Testing of grout and mortar:
1. During progress of construction, the Owner will have tests made to determine whether the grout and mortar, as being produced, complies with Specifications.
2. Compressive strength test for grout: In accordance with ASTM C1019.
3. Owner's Representative will make and deliver test specimens to the laboratory and testing expense will be borne by the Owner.
4. Required number of tests:
    a. At least 2test specimens of grout will be made per week.
    b. At least 2test specimens of grout will be made for each floor level of masonry laid.
5. Do not use grout and mortar that does not meet specification.
    a. Remove such mortar and grout from Project site.
6. Make provisions for and furnish grout and mortar for test specimens and provide manual assistance to the Engineer in preparing test specimens.
7. Assume responsibility for care of and providing proper curing conditions for test specimens.

3.02 ADJUSTING

A. Repair of defective masonry:
1. Remove and replace or repair defective work.
2. Do not patch, repair, or cover defective work without inspection by the Engineer.
3. Provide repairs having strength equal to or greater than specified strength for areas involved.

END OF SECTION

SECTION 04216

ANCHORED CMU VENEER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Anchored CMU veneer.

1.02 SUBMITTALS

A. Product data.

B. Shop drawings: Include elevations of each wall indicating type and layout of units.

C. Samples: Include samples of masonry units in sufficient quantity to illustrate color range.

D. ICBO Evaluation Report for wall ties and anchoring system.

E. Test reports:
   1. Test reports for each type of CMU.
   2. Testing and reports are to be completed by and independent laboratory.
   3. Test reports shall include:
      a. Compressive strength.

F. Letter of certification.

1.03 REFERENCES

A. ASTM International (ASTM):
   1. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   2. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   3. A580 - Standard Specification for Stainless Steel Wire.
   4. A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

1.04 QUALITY ASSURANCE

A. Mock-up panel:
   1. Prior to starting construction of masonry, construct minimum 4-foot square mock-up panel.
   2. Use accepted materials containing each different kind and color of masonry units to illustrate wall design.
   3. When not accepted, construct another mock-up panel.
   4. When accepted, mock-up will be standard of comparison for remainder of masonry work.

5. Do not destroy or move mock-up panel until work is completed and accepted by the Owner.
6. Upon completion of Project, dispose of mock-ups in legal manner at offsite location.

B. Pre-installation meeting: Conduct as specified in Section 01312 - Project Meetings.

C. A letter of certification from the supplier of the materials attesting to compliance with the applicable specifications for grades, types, or classes included in these specifications, shall be provided at the time of, or prior to, delivery of the materials to the jobsite.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle masonry units as required to prevent discoloration, chipping, and breakage.

B. Locate storage piles, stacks, and bins to protect materials from heavy traffic.

C. Store masonry units off ground to prevent contamination by mud, dust, or materials likely to cause staining or other defects.

D. Cover materials when necessary to protect from the elements.

E. Remove chipped, cracked, and otherwise defective units from jobsite upon discovery.

1.06 PROJECT CONDITIONS

A. Cold weather requirements:
1. In accordance with building code as specified in Section 01410 - Regulatory Requirements.
2. Provide adequate equipment for heating masonry materials when air temperature is below 40 degrees Fahrenheit.

B. Hot weather requirements:
1. When ambient air temperature exceeds 100 degrees Fahrenheit, or when ambient air temperature exceeds 90 degrees Fahrenheit and wind velocity is greater than 8 miles per hour, implement hot weather protection procedures.
2. Wet mortarboard before loading and cover mortar to retard drying when not being used.
3. Do not spread mortar beds more than 48 inches ahead of placing masonry units.
4. Place masonry units within 1 minute of spreading mortar.

1.07 SEQUENCING AND SCHEDULING

A. Order masonry units well before start of installation (8 weeks minimum) to ensure adequate time for manufacturing.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. CMU masonry veneer units:
   1. CMU masonry veneer units as specified in Section 04220 - Concrete Unit Masonry.
   2. Surface texture: As specified in Section 04220 - Concrete Unit Masonry.
   3. Size: As specified in Section 04220 - Concrete Unit Masonry.
   4. Special sizes and shapes: As required for window and door soldier coursing and custom sills where indicated on the Drawings, bond beams, piers, lintels, control joints, and other special applications to minimize cutting.
   5. Color: Match color of existing buildings. Do not exceed variations in color and texture of samples accepted by the Engineer. Confirm color with owner.
   6. Mortar and grout: As specified in Section 04100 - Mortar and Masonry Grout.

B. Dovetail anchors: As specified in Section 03102 - Concrete Formwork.

C. Adjustable Veneer Joint Reinforcement & Ties: As specified in Section 04090 - Masonry Accessories.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect adjacent construction with appropriate means from mortar droppings and other effects of laying of masonry units.

B. Thoroughly clean foundations of laitance, grease, oil, mud, dirt, mortar droppings, and other objectionable matter.

3.02 INSTALLATION

A. CMU masonry veneer units:
   1. Use dry masonry units.
   2. Do not use wet or frozen masonry units.
   3. Lay units in uniform and true courses, level, plumb, and without projections or offset from adjacent units.
   4. Lay units to desired height with joints of uniform thickness.
   5. For CMU veneer over concrete wall surfaces, install dovetail anchors and reinforcing wires as specified in Section 03102 - Concrete Formwork.
   6. For CMU veneer over masonry wall surfaces, install adjustable veneer tie system as specified in Section 04090 - Masonry Accessories.
   7. Spot bedding with cement mortar at all anchor locations.
   8. Bond shall be plumb throughout.
   9. Lay units to avoid formation of cracks when units are placed.

10. Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Lay masonry within the following tolerances:
    a. Maximum variation from the plumb in the lines and surfaces of columns, walls, and in the flutes and surfaces of fluted or split faced blocks:
        1) In adjacent masonry units: 1/8 inch.
        2) In 10 feet: 1/4 inch.
        3) In any story or 20 feet maximum: 3/8 inch.
        4) In 40 feet or more: 1/2 inch.
    b. Maximum variations from the plumb for external corners, expansion joints, and other conspicuous lines:
        1) In any story or 20 feet maximum: 1/4 inch.
        2) In 40 feet or more: 1/2 inch.
    c. Maximum variations from the level or grades indicated on the Drawings for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
        1) In any bay or 20 feet maximum: 1/4 inch.
        2) In 40 feet or more: 1/2 inch.
    d. Maximum variations of the linear building lines from established position in plan and related portion of columns, walls, and partitions:
        1) In any bay or 20 feet maximum: 1/2 inch.
        2) In 40 feet or more: 3/4 inch.
    e. Maximum variation in cross sectional dimensions of columns and in thickness of walls:
        1) Minus: 1/4 inch.
        2) Plus: 1/2 inch.
    f. When positions of units shift after mortar has stiffened, bond is broken, or cracks are formed, relay units in new mortar.
11. Prevent mortar from staining the face of masonry to be left exposed or painted:
    a. Immediately remove mortar in contact with face of such masonry.
    b. Protect all sills, ledges, and projections from droppings of mortar. Protect door jambs and corners from damage during construction.
12. Protect masonry not being worked on from rain by completely covering with a weather resistive membrane.

B. Mortar joints:
    1. Make joints straight, clean, smooth, and uniform in thickness.
    2. Pointing: Tool exposed joints, slightly concave. Strike concealed joints flush.
    3. Joint thickness: Make vertical and horizontal joints 3/8-inch thick.
    4. Where fresh masonry joins totally or partially set masonry, clean and roughen set masonry before laying new units.

C. Bond pattern:
    1. Lay masonry units in running bond pattern, except where special patterns are indicated on the Drawings.

D. Cutting masonry units:
    1. When possible, use full units of the proper size in lieu of cut units. Cut units as required to form chases, openings, for anchorage, and for other appurtenances.
    2. Cut and fit units with power-driven carborundum or diamond disc blade saw.

E. Control joints:
   1. Control joint spacing:
      a. Provide control joints in masonry walls at locations indicated on the Drawings.
      b. If the location of control joints is not indicated on the Drawings, provide control joints at 20-foot maximum spacing. Submit proposed control joint spacing to the Engineer for acceptance.
   2. Make full height and continuous in appearance.
   3. Insert control joint filler in joints as wall is constructed.
   4. Apply sealant as specified in Section 07900 - Joint Sealants.

F. Steel door frames:
   1. Anchor and fully grout jambs and head of steel doorframes connected to masonry.
   2. Fill frames with grout as each 2 feet of masonry is laid.

G. Enclosures:
   1. Where masonry units enclose conduit, pipes, stacks, ducts, and similar items, construct chases, cavities, and similar spaces as required, whether or not such spaces are indicated on the Drawings.
   2. Point openings around flush mounted electrical outlet boxes with mortar, including flush joints above boxes.
   3. Do not cover enclosures until inspected and when appropriate, tested.

H. Other embedded items:
   1. Build in wall plugs, accessories, flashings, pipe sleeves, and other items required to be built-in as the masonry work progresses.

I. Patching:
   1. Patch exposed masonry units in such manner that patching will be indistinguishable from similar surroundings and adjoining construction.

J. Water curing:
   1. Protect masonry units from drying too rapidly by frequently fogging or sprinkling for minimum of 3 days.

K. Miscellaneous:
   1. Build in required items, such as anchors, flashings, sleeves, frames, structural steel, lintels, anchor bolts, and metal fabrications, as required for complete installation.

L. Water repellent:
   1. Apply water repellent as specified in Section 07190 - Water Repellants.

M. Cleaning:
   1. Exercise extreme care to prevent mortar splotches.
   2. Do not attach construction supports to masonry walls.
   3. Wash off brick scum and grout spills before scum and grout set.
   4. Remove grout stains from walls.
   5. Clean exposed masonry. Remove scaffolding and equipment. Dispose of debris, refuse, and surplus material offsite legally.

6. Correct efflorescence on exposed surfaces with commercially prepared cleaning solution acceptable to masonry unit manufacturer:
    a. Apply cleaning solution in accordance with cleaning solution manufacturer's printed instructions.
    b. Do not use muriatic acid as cleaning solution.
    c. Do not use sandblast cleaning equipment.

N. Forms and shores:
1. Where required, construct forms to the shapes indicated on the Drawings:
    a. Construct forms sufficiently rigid to prevent deflection which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout.
    b. Do not remove supporting forms or shores until the supported masonry has acquired sufficient strength to support safely its weight and any construction loads to which it may be subjected:
        1) Wait at least 16 hours after grouting masonry columns or walls before applying uniform loads.
        2) Wait at least 72 hours before applying concentrated loads.

3.03 PROTECTION

A. Provide temporary protection for exposed masonry corners subject to damage.

B. Bracing:
1. Adequately brace masonry walls over 8 feet in height to prevent overturning and to prevent collapse unless wall is adequately supported by permanent supporting elements so wall will not overturn or collapse.
2. Keep bracing in place until permanent supporting elements of structure are in place.

C. Limited access zone:
1. Establish limited access zone prior to start of masonry wall construction.
2. Zone shall be immediately adjacent to wall and equal to height of wall to be constructed plus 4 feet by entire length of wall on unscaffolded side of wall.
3. Limit access to zone to workers actively engaged in constructing wall. Do not permit other persons to enter zone.
4. Keep zone in place until wall is adequately supported or braced by permanent supporting elements to prevent overturning and collapse.

3.04 FIELD QUALITY CONTROL

A. Site tests:
1. Efflorescence tests:
    a. Perform efflorescence tests on mortar that will be exposed to weathering. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary.

END OF SECTION

SECTION 04220

CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Concrete masonry units and accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C90 - Standard Specification for Loadbearing Concrete Masonry Units.
   2. C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   3. C426 - Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.

B. The Masonry Society (TMS):
   1. 602 - Specification for Masonry Structures.

1.03 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Grout lift height: The height of grout placed in a single continuous operation within the grout pour height.
   2. Grout pour height: Entire height of the masonry to be grouted prior to the construction of additional masonry.
   3. Mortar smears: Mortar paste smeared across the permanent masonry construction during construction and absorbed into the masonry pores.
   4. Mortar splash: Mortar dropped splashed onto the permanent masonry construction at the base of the wall or off the scaffolding.
   5. Mortar stains: Mortar paste left after mortar tags are removed.
   6. Mortar tag: Excess mortar between masonry units worked out of the joints during tooling or striking.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Submit manufacturer’s product data for proposed cleaning agent.

C. Shop Drawings:
   1. Include elevations of each wall indicating type and layout of units, including type of mortar joints, bond pattern, reinforcing steel, connecting dowels, joint reinforcement, grouted cells, and control joints.

D. Samples: Include samples of stretcher units in sufficient quantity to illustrate color range.

E. Test reports:
   1. Compressive strength.
   2. Linear shrinkage.
   3. Moisture content as a percentage of total absorption.
   4. Total absorption.
   5. Unit weight.

F. Manufacturer's instructions:
   1. Submit printed or written recommendations from the masonry unit manufacturer of the cleaning procedures and cleaning agents appropriate for each type of masonry unit included in the Work.

G. Quality assurance Submittals:
   1. If requested by the Engineer, submit a record of the installer's evidence of qualifications.
   2. If requested by the Engineer, submit a record of the masonry cleaner's evidence of qualifications.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Mason shall hold an appropriate contractor's license in the state where the Work will be constructed.
      b. Mason shall have not less than 5 years' experience and completed a minimum of 20 projects, at least 5 of which included the type of masonry units specified for this Work.
      c. Mason shall hold current certification demonstrating successful completion of the quality certification program administered by the Rocky Mountain Masonry Institute or the Mason Contractors Association of America.
   2. Masonry cleaner qualifications:
      a. Shall have not less than 5 years' experience and completed a minimum of 20 projects, at least 5 of which included the type of masonry units specified for this Work.

B. Mockup:
   1. A minimum 2 weeks before starting construction of masonry, construct minimum 4 foot inches by 4 foot inches square mockup.
      a. Mockup shall be constructed by the mason who will be performing the Work.
   2. Intended for use as the project standard of workmanship, construction, quality, appearance, and material selection.

3. Use accepted materials containing each different kind and color of concrete masonry units to illustrate wall design.
4. Constructed by the mason who will be performing the Work.
5. Cleaned with the exact equipment, products, and methods submitted and cleaned by the individual who will perform the Work.
6. When accepted, mockup will be standard of comparison for remainder of masonry work.
    a. May be accepted by the Engineer with exceptions that will not be accepted in the final construction.
        1) In such cases, those areas of the mockup not accepted will be clearly identified by the Engineer.
7. When not accepted by the Engineer, construct another mockup.
8. Upon completion of the Project, dispose of mockups in legal manner at offsite location.

C. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle concrete masonry units as required to prevent discoloration, chipping, and breakage.

B. Store masonry units off the ground in a dry location, covered and protected from absorbing moisture.
1. Locate storage piles, stacks, and bins to protect materials from heavy traffic.
2. If masonry units are delivered in shrink-wrapped packaging and condensation develops, remove shrink-wrap packaging.

C. Remove masonry units that are chipped, cracked, and otherwise defective from jobsite upon discovery.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Cold weather requirements:
1. Provide adequate equipment for constructing and protecting masonry when air temperature is:
    a. Below 40 degrees Fahrenheit as follows:
        1) Remove frozen snow and ice from surfaces to receive masonry.
        2) Do not use masonry units having visible snow or ice on the surface or containing frozen moisture.
        3) Do not lay masonry units that have a temperature of 20 degrees Fahrenheit or below.
    b. 32 degrees Fahrenheit to 40 degrees Fahrenheit:
        1) As required above and as follows:
            a) Heat aggregates and/or mix water to provide mortar between 40 degrees Fahrenheit and 120 degrees Fahrenheit.
            b) Heat aggregates and/or mix water to provide grout between 32 degrees Fahrenheit and 120 degrees Fahrenheit.
            c) Do not heat any constituents above 140 degrees Fahrenheit.

d) Protect newly constructed masonry work by covering surfaces with a weatherproof covering for 48 hours after completion.

c. 25 degrees Fahrenheit to 32 degrees Fahrenheit:
   1) As required above and as follows:
      a) Furnish mortar at point of use above 32 degrees Fahrenheit until immediately prior to incorporation into the Work.
      b) Heat aggregates and/or mix water to provide grout between 70 degrees Fahrenheit and 120 degrees Fahrenheit until immediately prior to incorporation into the Work.
      c) Protect newly constructed masonry work by covering surfaces with a weatherproof covering for 48 hours after completion.

d. 20 degrees Fahrenheit to 25 degrees Fahrenheit:
   1) As required above and as follows:
      a) Heat masonry units and adjoining completed Work to a minimum temperature of 40 degrees Fahrenheit.
      b) Use enclosures or wind breaks when wind speeds exceed 15 mph.
      c) Heat masonry to a minimum of 40 degrees Fahrenheit and maintain prior to grouting.
      d) Protect newly constructed masonry work by covering surfaces with weatherproof, insulating concrete blankets for 48 hours after completion.

e. Below 20 degrees Fahrenheit:
   1) As required above and as follows:
      a) Provide an auxiliary heated enclosure that maintains the ambient air temperature above 32 degrees Fahrenheit.
         (1) Heat shall not vent combustion products into the enclosure.
         (2) Maintain specified temperature for a minimum 48 hours after completion of masonry Work.

B. Hot weather requirements:
   1. Provide adequate equipment for constructing and protecting masonry as follows:
      a. When the air temperature exceeds 90 degrees Fahrenheit with a wind speed greater than 8 mph, or when the air temperature exceeds 100 degrees Fahrenheit:
         1) Maintain sand for mortar and grout in damp, loose piles. Shade material stockpiles and mixing equipment from direct sunlight.
         2) Provide mortar and grout below 120 degrees Fahrenheit.
         3) Flush mixer and mortar containers with cool water before use.
         4) Wet mortarboard before loading and cover mortar to retard drying when not being used.
         5) Do not spread mortar beds more than 48 inches ahead of placing masonry units.
         6) Place masonry units within 1 minute of spreading mortar.
         7) Use mortar within 1 hour of initial mixing.
         8) Protect masonry from drying by frequently fogging or sprinkling so walls will always be visibly damp for minimum 3 days.

b. When the air temperature exceeds 105 degrees Fahrenheit with a wind speed greater than 8 mph, or when the air temperature exceeds 115 degrees Fahrenheit:
    1) As required above and as follows:
        a) Use water less than 70 degrees Fahrenheit to batch mortar and grout. Ice is permitted to precool the mix water but must be fully melted before adding to other constituents.

1.08 SEQUENCING AND SCHEDULING

A. Order concrete masonry units well before start of installation to ensure adequate time for manufacturing and minimum 28 days for curing and drying before start of installation. Protect from weather after curing period to avoid moisture increase.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Hollow load bearing concrete masonry units:
    1. Density classification: Light weight in accordance with ASTM C90 with a minimum net area compressive strength as follows:
        a. Average of 3 units: 2,000 pounds per square inch.
        b. Any individual unit: 2,000 pounds per square inch.
    2. Surface texture: Precision (smooth face) with dense faces suitable for painting where scheduled to be painted.
    3. Color: Integral, Natural gray of concrete.
    4. Admixtures:
        a. Integral water repellent admixture:
            1) Manufacturers: One of the following or equal:
                a) Euclid Chemical Company, Blocktite.
                b) W.R. Grace & Co., DRY-BLOCK Block Admixture.
            2) Added to the concrete unit masonry at the time of manufacture.
            3) Used for the concrete masonry units and the mortar shall be produced by the same manufacturer.
            4) Provide integral water repellent admixtures for the following block walls:
                a) All exterior walls.
    5. Typical size: 8 inches and 12 inches wide by 8 inches high by 16 inches long, unless otherwise indicated on the Drawings, or other sizes as needed to minimize cutting.
    6. Special sizes and shapes: As required for window and door openings, bond beams, piers, lintels, control joints, and other special applications to minimize cutting.
    7. Manufacturers: One of the following or equal:
        a. W.R. Grace & Co., DRY-BLOCK block Admixture.
        b. BASF Corporation, MasterPel (Rheopel) Series Admixture.
    8. Concrete masonry units with an integral water repellent shall comply with the following:
        a. Achieve “E” (excellent) rating when tested in accordance with ASTM E514-74 for 72 hours.

b. No visible dampness on backs of 3 wall specimens when tested in accordance with current ASTM E514.
c. Coordinate testing with Section 04100 - Mortar and Masonry Grout.

B. Anchor bolts: As specified in Section 05120 - Structural Steel Framing

C. Steel reinforcement: As specified in Section 04090 - Masonry Accessories.

D. Wall ties: As specified in Section 04090 - Masonry Accessories.

E. Wire joint reinforcement: As specified in Section 04090 - Masonry Accessories.

F. Loose fill insulation: As specified in Section 04090 - Masonry Accessories.

G. Surface-applied water repellent: As specified in Section 07190 - Water Repellants.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection:
1. Protect adjacent construction with appropriate means from mortar droppings and other effects of laying of concrete masonry units.

B. Surface preparation:
1. Thoroughly clean foundations of laitance, grease, oil, mud, dirt, mortar droppings, and other matter that will reduce bond.
2. Examine foundation to confirm it is constructed within tolerance for masonry Work. Confirm dowels are installed in correct locations and with proper projection for the required lap splice before beginning laying masonry units.
3. Place sand, straw, sawdust or other similar material on the floor around the base of walls to protect floors and walls.

3.02 INSTALLATION

A. General:
1. Standard level of quality: Furnish conventional quality work having no more than 5 percent of the units in the completed Work exhibiting one or more of the following defects:
a. Chips larger than 1 inch in any direction.
b. Cracks wider than 0.02 inch and longer than 25 percent of the nominal height of the unit.
c. Completed work shall not show chips, cracks, or other imperfections when viewed from a distance of 20 feet under diffused lighting.

B. Temporary forms and shores:
1. Where required, construct forms to the shapes indicated on the Drawings:
a. Construct forms sufficiently rigid to prevent deflection which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout.

b. Do not remove supporting forms or shores until the supported masonry has acquired sufficient strength to support safely its weight and any construction loads to which it may be subjected.
1) Wait at least 24 hours after grouting masonry columns or walls before applying uniform loads.
2. Wait at least 72 hours before applying concentrated loads.

C. Laying of masonry units - General:
1. Lay concrete masonry units dry. Units having wet surfaces over 50 percent or more of its surface area may not be placed. Wet surfaces are distinguished from damp surfaces as those which do not darken when additional water is applied.
2. Lay units in uniform and true courses, level, plumb, and without projections or offset of adjacent units.
3. Lay units to preserve unobstructed vertical continuity of cells to be filled with grout or insulation.
4. When possible, use full units of the proper size in lieu of cut units. Cut units as required to form chases, openings, for anchorage, and for other appurtenances.
a. Cut and fit units with power-driven carborundum or diamond disc blade saw.
5. Align vertical cells to be filled with grout to maintain clear, unobstructed continuous vertical cell measuring not less than 2.5 inches by 3 inches.
6. Lay concrete masonry units in running bond pattern, unless otherwise indicated on the Drawings.
7. Where practical, protect completed work from mortar splash by placing thin plastic sheeting around the base of walls.

D. Mortar joints:
1. Make joints straight, clean, smooth, and uniform in thickness. Bond shall be plumb throughout.
2. Make vertical and horizontal joints 3/8-inch thick.
3. Place mortar with full coverage of joints at webs of all cells and face shells.
a. Ensure full mortar coverage of joints on webs of cells that will be grouted solid, and face shells.
4. Butter vertical head joints for thickness equal to face shell thickness of units, and shove joints tightly together so that mortar bonds to both masonry units.
5. Solidly fill joints from face of units to inside face of cells.
6. Where fresh masonry joins totally or partially set masonry, clean and roughen set masonry before laying new units.
7. Lay units to avoid formation of cracks when units are placed.
8. Keep cells of units as free of mortar as possible as masonry wall height increases.
9. When positions of units shift after mortar has stiffened, bond is broken, or cracks are formed, relay units in new mortar.
10. Tool exposed joints, slightly concave. Strike concealed joints flush.

E. Wire joint reinforcement:
1. Lap splice longitudinal wire joint reinforcement minimum 40 wire diameters, but not less than 6 inches.
2. Place longitudinal wires in approximate centers of mortar beds with minimum 5/8-inch mortar cover on exposed faces.

3. Provide intersecting masonry walls with prefabricated wire joint reinforcement tees.
4. Rake intersecting joints 1/2 inch and caulk joints.
5. Remove mortar, mortar droppings, debris, and other obstructions and materials from inside of cell walls.

F. Masonry control joints:
1. Provide in masonry walls at locations indicated on the Drawings.
2. Make full height and continuous in appearance.
3. Run bond beams and bond beam reinforcing bars continuously through control joints.
4. Insert control joint filler in joints as wall is constructed.
5. Apply sealant as specified in Section 07900 - Joint Sealants.
6. Steel door frames:
   a. Anchor and fully grout jambs and head of steel doorframes connected to concrete unit masonry.
   b. Fill frames with grout as each 2 feet of concrete unit masonry is laid.
7. Anchor bolts:
   a. Hold in place with template during grouting to ensure precise alignment.
   b. Do not cut or ream members being anchored or use other means to accommodate misaligned anchor bolts in roof deck support angles.
8. Enclosures:
   a. Where concrete masonry units enclose conduit, pipes, stacks, ducts, and similar items, construct chases, cavities, and similar spaces as required, whether or not such spaces are indicated on the Drawings.
   b. Point openings around flush mounted electrical outlet boxes with mortar, including flush joints above boxes.
   c. Do not cover enclosures until inspected and when appropriate, tested.
9. Conduits and electrical boxes:
   a. See Drawings for details of conduit installation in masonry.
10. Other embedded items:
    a. Build in wall plugs, accessories, flashings, pipe sleeves, and other items required to be built-in as the masonry work progresses.
11. Miscellaneous:
12. Build in required items, such as anchors, flashings, sleeves, frames, structural steel, lintels, anchor bolts, and metal fabrications, as required for complete installation.

G. Daily cleaning:
1. Remove mortar tags and smears daily with a non-metallic tool.
   a. Removed after they initially set but shall not be permitted to remain more than 24 hours.
2. Turn scaffold planks over at the end of the workday to avoid mortar splashes from wet weather.
   a. Cover tops of walls at the end of the workday and other work stoppages to prevent entry of water into the partially completed masonry.
3. Seal cleanouts after inspection and before grouting or placing insulation.

H. Grouting and reinforcement:
1. Where horizontal and vertical bars are spliced, the lap splice length shall be in accordance with TMS 602 and as indicated on the Drawings.

2. Hold vertical reinforcing bars in position at top and bottom and at intervals not exceeding 200-bar diameters.
    a. Use steel wire bar positioners to position bars.
    b. Tie reinforcing bars to dowels with wire ties.
3. Obtain acceptance of reinforcement placement before grouting.
    a. Grouting:
        1) Grout pour height shall be limited to a maximum of 5.33 feet, unless the Contractor submits sufficient evidence to the Engineer for review and acceptance that the requirements of TMS 602 as it relates to grout pour height can be met.
        2) Grout lift height shall be limited to a maximum of 5.33 feet, unless the Contractor submits sufficient evidence to the Engineer for review and acceptance that the requirements of TMS 602 as it relates to grout lift height can be met.
        3) Slushing with mortar will not be permitted.
        4) Allow hollow unit masonry to cure at least 24 hours prior to grouting.
        5) Each lift shall be allowed to set for 10 minutes after initial consolidation of grout before successive lift is placed.
        6) Full height of each section of wall shall be grouted in 1 day.
4. Placement:
    a. Use a hand bucket, concrete hopper, or grout pump.
    b. Do not pump grout through aluminum tubes.
    c. Operate pumps to produce a continuous stream of grout without air pockets.
    d. Upon completion of each day's pumping, eject grout from pipeline without contamination or segregation of the grout. Remove from site and dispose. Do not incorporate into masonry Work.
    e. Place grout so as to completely fill the grout spaces without segregation of the aggregates.
    f. Remove grout spills immediately by hand washing with a bucket and brush.
    g. Grout in cells shall have full contact with surface of concrete footings.
    h. Time constraints:
        1) When grouting stops for 1 hour or longer, form horizontal construction joints by stopping grout placement 1-1/2-inches below top of uppermost unit containing grout.
        2) Place grout in final position within 1-1/2-hours after mixing. Place grout so as to completely fill the grout spaces without segregation of the aggregates.
    i. Consolidation:
        1) Do not insert vibrators into lower grout placements that are in a semi-solidified state.
        2) After placement, consolidate grout using mechanical immersion vibrators designed for consolidating grout.
        3) Maintain at least 1 spare vibrator at the site at all times.
        4) Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine.
        5) Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

3.03 TOLERANCES

A. Masonry tolerances: Lay masonry plumb, true to line, and with courses level. Keep bond pattern plumb throughout. Lay masonry within the following tolerances:
   1. Maximum variation from the plumb in the lines and surfaces of columns, walls, and in the flutes and surfaces of fluted or split faced blocks:
      a. In adjacent masonry units: 1/8 inch.
      b. In 10 feet: 1/4 inch.
      c. In any story or 20 feet maximum: 3/8 inch.
      d. In 40 feet or more: 1/2 inch.
   2. Maximum variations from the level or grades indicated on the Drawings for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
      a. In any bay or 10-feet maximum: 1/4 inch.
      b. In 40 feet or more: 1/2 inch.
   3. Maximum variations of the linear building lines from established position in plan and related portion of columns, walls, and partitions:
      a. In any bay or 20-feet maximum: 1/2 inch.
      b. In 40 feet or more: 3/4 inch.
   4. Maximum variation of top surface of bearing walls from level:
      a. In any bay or 20-feet maximum: 1/4 inch.
      b. In 40 feet or more: 1/2 inch.
   5. Maximum variation in cross sectional dimensions of columns and in thickness of walls:
      a. Minus: 1/4 inch.
      b. Plus: 1/2 inch.
   6. Mortar bed joint thickness between masonry courses:
      a. Plus or minus: 1/8 inch.

3.04 FINAL CLEANING

A. General:
   1. Patch exposed concrete masonry units at completion of the Work and in such manner that patching will be indistinguishable from similar surroundings and adjoining construction.
   2. Final cleaning shall be performed within 7 to 14 days after construction of masonry work.
   3. Protect adjacent materials and equipment that may be damaged by cleaning.
   4. Pre-wet masonry before applying cleaning agent but do not saturate masonry.
   5. Remove mortar stains, smears, and splash, efflorescence, and grout stains on exposed surfaces with the submitted cleaning agent as directed by the masonry unit manufacturer's recommendations.
   6. Do not use muriatic acid as cleaning agent.
   7. Cleaning agents shall be applied when the masonry surface and air temperatures are at least 50 degrees Fahrenheit.
      a. Dilute cleaning agents in accordance with the manufacturer's recommendations.
      b. Do not allow cleaning agents to dry on the masonry.
   8. Clean wall from the top to the bottom, without overlapping areas being cleaned for consistency.

9. If pressure cleaning equipment is used, the following limitations shall be observed:
    a. Apply cleaning agent to pre-wetted wall with low pressure (less than 50 pounds per square inch).
    b. Use a 25 degree to 50 degree flared-tip nozzle (not a pointed tip).
    c. Maintain a consistent distance from the spray nozzle to the masonry surface no closer than 12 inches.
        1) Masonry cleaner shall use a combination of pressure, nozzle, and distance from tip to masonry that does not damage the masonry surface.
10. Rinse cleaning agents off the wall with potable water.
11. Dispose of debris, refuse, and surplus material offsite legally.

3.05 FIELD QUALITY CONTROL

A. Site tests:
    1. Owner will have tests performed by an independent laboratory.
    2. Have minimum 3 concrete masonry units of each type proposed for Project tested in accordance with ASTM C90, C140, and C426 to verify conformance to Specifications.
    3. Tests shall include compressive strength, linear shrinkage, moisture content as percent of total absorption, total absorption, and unit weight.

3.06 PROTECTION

A. Provide temporary protection for exposed masonry corners subject to damage.

B. Bracing:
    1. Unless wall is adequately supported by permanent supporting elements so wall will not overturn or collapse, adequately brace masonry walls over 8 feet in height to prevent overturning and to prevent collapse.
    2. Keep bracing in place until permanent supporting elements of structure are in place.

C. Limited access zone:
    1. Establish prior to start of masonry wall construction.
    2. Zone shall be immediately adjacent to wall and equal to height of wall to be constructed plus 4 feet by entire length of wall on unscaffolded side of wall.
    3. Limit access zone to workers actively engaged in constructing wall. Do not permit other persons to enter zone.
    4. Keep zone in place until wall is adequately supported or braced by permanent supporting elements to prevent overturning and collapse.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners and structural hardware:
      a. All thread rods.
      b. High-strength bolts.
   3. Welding.
   4. Bolting.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

B. American Iron and Steel Institute (AISI):
   1. Steel and stainless steel alloys (“types”) as indicated.

C. American Welding Society (AWS):
   1. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   2. A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   3. A5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   4. D1.1 - Structural Welding Code - Steel.
   5. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   6. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   7. A276 - Standard Specification for Stainless Steel Bars and Shapes.

8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
9. A489 - Standard Specification for Carbon Steel Lifting Eyes.
10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
13. A992 - Standard Specification for Structural Steel Shapes.
14. F436 - Standard Specification for Hardened Steel Washers.
15. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
16. F594 - Standard Specification for Stainless Steel Nuts.
17. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
18. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
19. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. Research Council on Structural Connections (RCSC):
1. Specification for Structural Joints Using High-Strength Bolts (RCSC Specification).

1.03 DEFINITIONS

A. Snugtight: At bolted joints, the tightness attained with a few impacts of an impact wrench, or by the full effort of an ironworker using a spud wrench to bring the connected plies into firm contact.

B. Stainless steel related terms:
1. Descaling: Removal of heavy, tightly adherent oxide films resulting from hot-forming, heat-treatment, welding, and other high-temperature operations.
2. Pickling: Chemical descaling of stainless steel using aqueous solutions of nitric and hydrofluoric acid, or various proprietary formulations as specified.
3. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel’s protective passive film.

1.04 SUBMITTALS

A. Product data:
1. Welding electrodes for field welds: Electrode manufacturer's data.
2. Compressible-washer-type direct tension indicators: Manufacturer’s detailed installation instructions including:
a. Requirements for type and frequency of pre-installation verification.
b. Requirements for coordination with regular washers.
c. Instructions for assembling and tightening the joint so that work progresses from the most rigid part until the connected plies are in firm contact.

3. Stainless steel: Fabricator name and qualifications, member dimensions and structural section properties, and specifications and procedures used for pickling and passivating members.

B. Shop drawings:
   1. Fabrication and erection drawings.

C. Quality control submittals:
   1. Welding procedure specifications (WPS) in accordance with AWSD1.1 and D1.6.
      a. Submit WPS for each type of welded joint used, whether prequalified or qualified by testing.
         1) State electrode manufacturer and specific electrodes used.
         2) Indicate required AWS qualification for joint.
      b. Submit WPS with shop drawings that indicate those welds.
      c. Submit Procedure Qualification Record (PQR) in accordance with AWS D1.1 and D1.6 for welding procedures qualified by testing.
   2. Welder qualifications: For each welding process and position:
      a. Welder's qualification certificates.
      b. Contractor's statement that certificate will be "in effect" at the time(s) welding will be performed based on the "Period of Effectiveness" provisions of AWS D1.1 and D1.6.
   3. Steel fabricator's AISC certification.

D. Test reports:
   1. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

1.05 QUALITY ASSURANCE

A. Certification:
   1. Steel fabricators shall be certified by the AISC or other certification acceptable to the Engineer and the building official having jurisdiction.

B. Welding:
   1. Perform welding of structural metals in accordance with AWSD1.1 and D1.6 using welders who have current AWS qualification certificate for the process, position, and joint configuration to be welded.
   2. Make Welding Procedure Specifications available at the locations where welding is performed.
   3. Notify Engineer at least 24 hours before starting shop or field welding.
   4. Engineer may check materials, equipment, and qualifications of welders.
   5. Remove welders performing unsatisfactory Work, or require requalification.
   6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
   7. Contractor shall bear costs of retests on defective welds.
   8. Contractor shall also bear costs in connection with qualifying welders.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

Item	ASTM Standard	Class, Grade, Type, or Alloy Number
Carbon Steel		
Plate, bars, rolled shapes (except W and WT shapes), and miscellaneous items	A36	--
Rolled W and WT shapes	A992	Grade 50
Hollow structural sections/HSS: Round, square, or rectangular (including “pipe” where indicated for structural members and supports)	A500	Grade C
Stainless Steel		
Plate, sheet, and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**
* Use Type 304L (low-carbon stainless steel) if material will be welded.		
** Use Type 316L (low carbon stainless steel) if material will be welded.		

2.02 FASTENERS AND STRUCTURAL HARDWARE

A. General:
   1. Materials: Of domestic manufacture.
   2. Where fasteners and hardware are specified to be galvanized, hot-dip galvanize in accordance with ASTM A153 or ASTM F2329, unless otherwise specified.

B. All thread rods:
   1. Carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
      b. Nuts: ASTM A194.
      c. Washers: ASTM F436.

2. Galvanized carbon steel:
    a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
    b. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
    c. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.
3. Stainless steel:
    a. Units descaled, pickled, and passivated as specified in “Fabrication” in this Section.
    b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
    c. Alloy Type 304 or Type 316 as indicated on the Drawings.
    d. Type 304:
        1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
        2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
        3) Washers: Type 304 stainless steel.
    e. Type 316:
        1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
        2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
        3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

D. High-strength bolts:
1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators. Provide uncoated components unless galvanized coating is indicated on the Drawings.
2. Carbon steel - Uncoated:
    a. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1.
    b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
    c. Washers:
        1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1. Flat circular washers unless otherwise indicated on the Drawings.
        2) Adjacent to long slotted holes: Fabricated from 5/16-inch thick plate conforming to ASTM A36.
    d. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
        1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1.
        2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852.
3. Carbon steel - Galvanized:
    a. Bolt and nut assemblies fabricated, galvanized, tested for rotational capacity, and shipped accordance with the provisions ASTM F3125, Grade A325and the RCSC Specification.

b. Bolts, nuts, and washers: Hot-dip galvanized in accordance with ASTM F2329.
c. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1 and galvanized as specified.
d. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade DH, galvanized as specified, and lubricated in accordance with ASTM A563, Supplementary Requirement S1 to minimize galling.
e. Washers:
    1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1 and galvanized as specified. Flat circular washers unless otherwise indicated on the Drawings.
    2) Adjacent to long slotted holes: 5/16-inch thick plate washer fabricated from steel conforming to ASTM A36, and galvanized in accordance with ASTM A123.
f. Load indicator devices: At slip critical connections, provide one of the following devices at each bolt:
    1) Compressible washer type direct tension indicators (“DTI”): In accordance with ASTM F959, Type 325-1, with mechanically deposited zinc coating conforming to ASTM B695, Class 55.
    2) Twist-off type tension-control bolt assemblies: ASTM F3125, Grade F1852 with mechanically deposited zinc coating conforming to ASTM B695, Class 55.

E. Stainless steel bolts (for use in stainless steel structures):
1. General:
    a. Bolts and nuts shall be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship bolts with properly fitting nuts attached.
    b. Units descaled, pickled and passivated as specified in “Fabrication."
2. Alloy: Type 304 or Type 316 to match alloy of structural members being connected.
3. Type 304:
    a. Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 304 stainless steel.
4. Type 316:
    a. Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 316 stainless steel.
5. Welded studs: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.03 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.04 GALVANIZED SURFACE REPAIR

A. Manufacturers: The following or equal:
   1. Jelt, Galvinox.

2.05 THREAD COATING

A. Manufacturers: One of the following or equal:
   1. Bostik, Never-Seez.
   2. Oil Research, Inc., WLR No. 111.

2.06 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.07 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. Round off sharp and hazardous projections and grind smooth.
   4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
   5. Take responsibility for correct fitting of metalwork.
   6. Welded connections:
      a. Comply with AWS requirements for the metals to be welded.
      b. Weld only in accordance with approved Welding Procedure Specifications.
      c. Keep Welding Procedure Specifications readily available for welders and inspectors during fabrication processes.

B. Stainless steel shapes and assemblies:
   1. For structural members such as W shapes, S shapes, channels, angles, and similar rolled shapes not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
      a. Fabricate shapes using laser-fused, full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as that of members indicated on the Drawings.
      b. Fabricate shapes from dual grade stainless steel.
      c. Fabricate beams and channels to ASTM A6 tolerances.
      d. Manufacturers: The following or equal:
         1) Stainless Structural, LLC.
   2. Cleaning and passivation:
      a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.

b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
    1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
d. Pre-clean, chemically de-scale ("pickle"), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380.
    1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.
    2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
    3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.
e. Inspect after cleaning using methods specified for "gross inspection" in ASTM A380.
f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

C. Galvanized carbon steel:
1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
3. Re-straighten galvanized items that bend or twist during galvanizing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
1. Fabricate structural and foundry items to true dimensions without warp or twist.
2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
4. Do not shift out of alignment, re-drill, re-shape, or force fit fabricated items.
5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.

6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
7. Erect structural steel in accordance with AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
9. Round off sharp or hazardous projections and grind smooth.
10. Paint or coat steel items as specified in Sections 09910 - Painting and 09960 - High-Performance Coatings.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling.
   1. Segregate stainless steel from iron.
   2. Tools and handling devices.
      a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
      b. Do not use tools that have been contaminated by contact with iron.
      c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.
   2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding: Carbon steel:
   1. General: In accordance with AWS D1.1:
      a. Weld ASTM A36 and A992 structural steel, and ASTM A500 and A501 structural tubing with electrodes in accordance with AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes.
      b. Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.

E. Welding: Stainless steel:
   1. General: In accordance with AWS D1.6.
   2. Field welding of stainless steel will not be permitted.
   3. Passivation of field-welded surfaces:
      a. Provide cleaning, pickling and passivating as specified under “Fabrications” of this Section. Clean using Derustit Stainless Steel Cleaner, or equal.

F. Interface with other products:
   1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

G. Fasteners: General:
   1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
   2. Anchor bolts and anchor rods: Install as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snugtight" condition.

H. Fasteners: High-strength carbon steel bolts:
   1. Connections with high-strength bolts shall be in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Joints: Slip-critical.
      a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
      b. Furnish hardened flat washers in accordance with ASTM F436:
         1) On outer plies with slotted holes.
         2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
         3) Under element, nut, or bolt head, turned in tightening.
      c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
      d. Tighten bolts to full pretension.
   3. Joints: Pre-tensioned.
      a. Joint preparation, assembly, and tightening shall be as specified for slip-critical connections, except that the requirements for un-coated faying surfaces shall not apply.

3.03 FIELD QUALITY CONTROL

A. Provide quality control as specified in Section 01450 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455 - Regulatory Quality Assurance.

END OF SECTION

SECTION 05140

STRUCTURAL ALUMINUM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

1.02 REFERENCES

A. American Welding Society (AWS):
   1. A5.10 - Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
   2. D1.2 - Structural Welding Code - Aluminum.

B. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

1.03 SUBMITTALS

A. Quality control Submittals:
   1. Test Reports: Certified copies of mill tests or reports from a recognized commercial laboratory including chemical and tensile properties of each shipment of structural metal or part thereof having common properties. Tests and analyses shall be made in accordance with applicable ASTM Standards.
   2. Welder’s certificates.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Notify Engineer 24 hours minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work or require to requalify.
   5. Engineer may use gamma ray, magnetic particle dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall bear costs in connection with qualifying welders.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.

B. Structural aluminum: ASTM B308, Alloy 6061-T6.

C. Extruded aluminum: ASTM B221, Alloy 6063-T42.

D. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

E. Miscellaneous materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. In accordance with applicable ASTM Standards for materials not otherwise specified.

2.02 FABRICATION

A. Aluminum layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.000013 per degree of Fahrenheit.

B. Cutting aluminum:
   1. Material 1/2-inch thick or less: Shear, saw, or cut with a router.
   2. Material more than 1/2-inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly:
      a. Make finished diameter of holes for bolts 1/16-inch maximum larger than nominal bolt diameter.
      b. Make holes cylindrical and perpendicular to principal surface.
      c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum forming and assembly:
   1. Do not heat structural aluminum, except as follows:
      a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
      b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding aluminum:
   1. Perform welding of aluminum in accordance with AWS D1.2.
   2. Weld aluminum in accordance with the following:
      a. Preparation:
         1) Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
         2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
         3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
         4) Suitably prepare edges to ensure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
      b. Filler metal: Aluminum alloys in accordance with AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
      c. Perform welding of structures which are to be anodized using filler alloys which will not discolor when anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
      d. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
      e. Do not use welding process that requires use of a welding flux.
      f. Neatly make welded closures.
      g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
      h. Make welds full penetration welds unless otherwise indicated on the Drawings.

2.03 FINISHES

A. Coating for Aluminum in contact with concrete or masonry:
   1. Epoxy mastic.
      a. As specified in Section 09960 - High-Performance Coatings, coating system EPX-M-5.
      b. Manufacturers: One of the following or equal:
         1) Carboline, Carbomastic 15.
         2) International Paint, Bar-Rust 231.
         3) Tnemec, Series 135.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and true to level.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with other products:
   1. Where aluminum comes in contact with dissimilar metals, use stainless steel bolts or anchors and separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Coat those parts of aluminum that will be cast into concrete or that will be in contact with concrete, grout, masonry, wood, or other materials that will cause the aluminum to corrode, as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 05190

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Cast-in anchors and fasteners.
   2. Post-installed steel anchors and fasteners.
   3. Appurtenances for anchoring and fastening.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A29 - Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   4. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   5. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   6. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   7. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   9. A1064 - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plan and Deformed, for Concrete.
   10. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   11. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

12. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
13. F436 - Standard Specification for Hardened Steel Washers.
14. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
15. F594 - Standard Specification for Stainless Steel Nuts.
16. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
17. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
2. AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry.
3. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
1. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.
2. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.
3. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 45 degrees above a horizontal line so the fastener resists sustained tension loads.
4. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.
5. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.
6. Terms relating to structures or building environments as used with reference to anchors and fasteners:
    a. Corrosive locations: Describes interior and exterior locations as follows:
        1) Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
        2) Exterior and interior locations at the following treatment structures:
            a) Water treatment facilities: Liquids stream:
                (1) Caustic soda storage and feed.
                (2) Chlorine storage and feed rooms.
                (3) PEA, PEC, and PC feed and storage areas.

    b. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
        1) Exterior portions of buildings and structures.

2) Liquid-containing structures:
    a) Locations at and below the maximum operating liquid surface elevation.
    b) Locations above the maximum operating liquid surface elevation and:
        (1) Below the top of the walls containing the liquid.
        (2) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).
3) Liquid handling equipment:
    a) Bases of pumps and other equipment that handles liquids.
4) Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
5) Other locations indicated on the Drawings.

c. Other locations:
    1) Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 DELEGATED DESIGN

A. As specified in Section 01357 - Delegated Design Procedures.

B. Calculations.

1.05 SUBMITTALS

A. General:
    1. Submit as specified in Section 01330 - Submittal Procedures and Section 01600 - Product Requirements.

B. Product data:
    1. Cast-in anchors:
        a. Manufacturer’s data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
    2. Post-installed anchors:
        a. For each anchor type, manufacturer’s data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.

C. Delegated Design Submittals:
    1. When requesting product substitutions for post installed anchors, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section.

D. Samples:
    1. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.

E. Certificates:
   1. Cast-in anchors:
      a. Mill certificates for steel anchors that will be supplied to the site.
   2. Post-installed anchors:
      a. Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.

F. Test reports:
   1. Post-installed anchors: For each anchor type used for the Work:
      a. Current ICC-ES Report (ESR) demonstrating:
         1) Acceptance of that anchor for use under the building code specified in Section 01410 - Regulatory Requirements.
         2) That testing of the concrete anchor included the simulated seismic tension and shear tests of AC193, and that the anchor is accepted for use in Seismic Design Categories C, D, E, or F, and with cracked concrete.

G. Manufacturer's instructions:
   1. Requirements for storage and handling.
   2. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
   3. Requirements for inspection or observation during installation.

H. Qualification statements:
   1. Post-installed anchors: Installer qualifications:
      a. Submit list of personnel performing installations. Include letter of training from manufacturer indicating date of manufacturer's training for each installer.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Post installed anchors shall be in accordance with building code specified in Section 01410 - Regulatory Requirements.
   2. Installers: Post-installed mechanical anchors:
      a. Conduct a training session with the manufacturer's authorized technical representative for the Project on-site:
         1) Training shall cover the complete installation process for each type of anchor to be used and shall include, but not be limited to, hole drilling procedures and techniques, hole preparation and cleaning, bolt installation, and bolt proof loading and torquing.
         2) Use only trained and qualified personnel for anchor installation.
      b. Installations shall be performed by trained installers having at least 3 years of experience performing similar installations with similar types of anchors.

B. Special inspection:
   1. Provide special inspection of post-installed anchors as specified in Section 01455 - Regulatory Quality Assurance and this Section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

B. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

C. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

D. Protect anchors from weather and moisture until installation.

1.08 PROJECT CONDITIONS

A. As specified in Section 01850 - Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact the Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as specified in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.

2. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to the Engineer.
    a. Rods or bars with angle bend for embedment in concrete (i.e., “L” or “J” shaped anchor bolts) are not permitted in the Work.
3. Materials:
    a. Ship anchor bolts with properly fitting nuts attached.
    b. Type 316 stainless steel:
        1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
        2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
        3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
        4) Washers: Type 316 stainless steel.
    c. Type 304 stainless steel:
        1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
        2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
        3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
        4) Washers: Type 304 stainless steel.
    d. Galvanized steel:
        1) Hot-dip galvanized coating in accordance with ASTM F2329.
        2) Bolts: ASTM F1554, Grade 36**,** heavy hex, coarse thread.
        3) Nuts: ASTM A563, Grade A**,** heavy hex, threads to match bolt.
        4) Washers: ASTM F436, Type 1.

B. Anchor rods:
1. Straight steel rod having threads on each end[or continuously threaded from end to end. One threaded end is fitted with nuts or plates and embedded in concrete to the effective depth indicated on the Drawings, leaving the opposite threaded end to project clear of the concrete face as required for the connection to be made at that location.
2. Materials:
    a. Stainless steel: Type 316:
        1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
        2) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
        3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
        4) Washers: Type 316 stainless steel.
        5) Plates (embedded): ASTM A240.
    b. Stainless steel: Type 304:
        1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
        2) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
        3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads or rods.
        4) Washers: Type 304 stainless steel.
        5) Plates (embedded): ASTM A240.
    c. Galvanized steel:
        1) Hot-dip galvanized with coating in accordance with ASTM F2329.

2) Rod: ASTM F1554, Grade 36, coarse thread.
3) Nuts: ASTM A563, Grade A, threads to match rod.
4) Washers: ASTM F436, Type 1.
5) Plates (embedded): ASTM A36.

C. Welded studs:
1. Anchor with forged head for embedment into concrete on one end, and welding ferrule for attachment to steel on the other. Welded to steel members or plates to provide anchorage for steel connections to concrete.
2. Shall be in accordance with AWS D1.1, Type B.
3. Manufacturers: One of the following or equal:
a. Nelson Stud Welding (Stanley Engineered Fastening), H4L Concrete Anchors or S3L Shear Connectors as indicated on the Drawings.
b. Stud Welding Products, Headed Concrete Anchors (HCA) or Headed Shear Connectors (HSC) as indicated on the Drawings.
4. Materials:
a. Stainless steel: Type 316L
b. Stainless steel: Type 304L
c. Galvanized steel:
1) Hot-dip galvanized after fabrication with coating in accordance with ASTM A123.
2) Steel: Low carbon steel in accordance with ASTM A29/A108 with 51,000 pounds per square inch minimum yield strength, and 65,000 pounds per square inch minimum tensile strength.

D. Steel plates or shapes for fabrications including assemblies with welded studs or deformed bar anchors:
1. Stainless steel: Type 316L or Type 304L:
a. Plates (embedded): ASTM A240.
2. Galvanized steel:
a. Hot dip galvanized in accordance with ASTM A123.
b. Steel: ASTM A36.

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

B. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in masonry: As specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410 - Regulatory Requirements.
      a. Acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.
         2) To resist short-term loads due to wind forces.
         3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.

B. Concrete anchors:
   1. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. Sometimes referred to as “expansion anchors” or “wedge anchors.”
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
   2. Concrete expansion bolts for anchorage to concrete:
      a. Shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      b. Performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
      c. Manufacturers: One of the following:
         1) Hilti, Kwik Bolt TZ2 Wedge Anchor.
         2) Simpson Strong-Tie, Strong-Bolt 2 Wedge Anchor.
      d. Materials. Integrally threaded stud, wedge, washer, and nut:
         1) Stainless steel: Type 316.
            a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
         2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
   3. Concrete anchors for anchorage to concrete masonry (fully grouted cells):
      a. Shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified in accordance with ICC-ES AC01, including all mandatory tests and optional seismic tests.
      b. Manufacturers: One of the following or equal:
         1) DEWALT/Powers, Power-Stud+ SD1.
         2) Hilti, Kwik TZ2 Wedge Anchor.
         3) Simpson Strong-Tie, Strong-Bolt 2 Wedge Anchor.
      c. Materials. Integrally threaded stud, wedge, washer, and nut:
         1) Stainless steel: Type 316.
            a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.

2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or mechanically galvanized in accordance with ASTM B695, Class 55, Type 1.

C. Flush shells:
1. Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
2. Flush shell anchors are not permitted in the Work.

D. Sleeve anchors:
1. Post-installed, torque-controlled anchor assembly consisting of an externally threaded stud with a spacer sleeve near the surface of the base material, and an expansion sleeve on the lower part of the stud. Expansion sleeve is forced outward by torquing of the center stud to transfer load.
a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials in order to develop holding power.
2. Sleeve anchors for anchorage to concrete:
a. Shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
b. Performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
c. Manufacturers: One of the following or equal:
1) Hilti, HSL-3 Heavy Duty Expansion (sleeve) Anchor.
d. Materials:
1) Stainless steel: Type 316.
2) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
3. Sleeve anchors for anchorage to concrete masonry (fully grouted only):
a. Shall have a current ICC-ES Report demonstrating that anchors have been tested and qualified for performance in masonry, including short-term loading due to wind and seismic forces in accordance with ICC-ES AC01.
b. Manufacturers: One of the following or equal:
1) Hilti, HSL-3 Heavy Duty Expansion (sleeve) Anchor.

c. Materials:
1) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.

2. Plastic sleeves:
    a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
    b. Manufacturers: The following or equal:
        1) Portland Bolt & Manufacturing Co.
3. Fabricated steel sleeves: Construct as specified in Section 05500 - Metal Fabrications:
    a. At galvanized carbon steel anchor bolts, provide galvanized carbon steel sleeves.
    b. At stainless steel anchor bolts, provide stainless steel sleeves of same Type (304 or 316) as bolt, except that sleeves shall be constructed from low carbon stainless steel for welding (Type 304L or 316L.)
4. Fabricated steel sleeves:
    a. Fabricate to the following dimensions unless otherwise indicated on the Drawings:
        1) Inside diameter: At least 2 inches greater than bolt diameter.
        2) Inside length: Not less than 10-bolt diameters.
        3) Bottom plate:
            a) Square plate with dimensions equal to the outside diameter of the sleeve plus 1/2 inch each side.
            b) Thickness equal to or greater than one-half of the anchor bolt diameter.
    b. Carbon steel anchor bolts:
        1) Fabricated from ASTM A36 plate and ASTM A53, Grade B pipe.
        2) Welded connections: Conform to requirements of AWS D1.1.
        3) Hot dip galvanized in accordance with ASTM A153.
    c. Stainless steel anchor bolts:
        1) Fabricated from ASTM A240 plate and pipe. Type 304L or Type 316L to match Type of the anchor bolt.
        2) Welded connections: In accordance with AWS D1.6.

B. Forged steel hardware:
    1. As specified in Section 05120 - Structural Steel Framing for forged steel hardware connectors, including clevises, turnbuckles, eye bolts, eye nuts, and sleeve nuts.

C. Isolating sleeves and washers:
    1. Manufacturers: One of the following or equal:
        a. Allied Corrosion Industries.
        b. Central Plastics Co.
    2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending halfway into both steel washers.
    3. One sleeve required for each bolt.
    4. Washers: Inside diameter of washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter.
        a. Proper size to fit bolts.
        b. Two 1/8-inch thick steel washers for each bolt.
        c. G3 Phenolic: 2 insulating washers are required for each bolt:
            1) Thickness: 1/8 inch.
            2) Base material: Glass.

3) Resin: Phenolic.
4) Water absorption: 2 percent.
5) Hardness (Rockwell): 100.
6) Dielectric strength: 450 volts per mil.
7) Compression strength: 50,000 pounds per square inch.
8) Tensile strength: 20,000 pounds per square inch.
9) Maximum operating temperature: 350 degrees Fahrenheit.

D. Coating for repair of galvanized surfaces:
1. Manufacturers: The following or equal:
a. Jelt, Galvinox.

E. Thread coating: For use with threaded stainless steel fasteners:
1. Manufacturers: One of the following or equal:
a. Bostik, Never-Seez.
b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION - GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.

2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION - CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors.
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
      b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
      c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
      d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
   2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
   3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
   1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
   2. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment. Fill sleeves with grout when a machine or other equipment is grouted in place.

C. Anchor rods:
   1. Install as specified for anchor bolts.

D. Welded studs:
   1. Butt weld to steel fabrications with automatic stud welding gun as recommended by the manufacturer.
   2. Ensure that butt weld develops full strength of the stud.

3.04 INSTALLATION - POST-INSTALLED ADHESIVE ANCHORS

A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

B. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in masonry: As specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

3.05 INSTALLATION - POST-INSTALLED MECHANICAL ANCHORS

A. General:
   1. Install anchors in accordance with the manufacturer's instructions, ACI 355.2, the anchor's ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements specified in this Section, the requirements of the ICC-ES Report shall control.
   2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
   3. After anchors have been positioned and inserted into concrete or masonry, do not:
      a. Remove and reuse/reinstall anchors.
      b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
   1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
   2. Accurately locate holes:
      a. Before drilling holes, use a reinforcing bar locator to identify the position of reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
      b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
   3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
      a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await the Engineer's instructions before proceeding.
   4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
   5. Drill using anchor manufacturer's recommended equipment and procedures:
      a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
         1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
         2) Drill bits: Carbide-tipped in accordance with ANSI B212.15. Hollow drills with flushing air systems are preferred.
   6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
   7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
      a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
      b. Repeat cleaning process as required by the manufacturer's installation instructions.
      c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in compliance with the manufacturer's installation instructions.
   1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
	Minimum Effective Embedment Length		Minimum Member Thickness
Nominal Diameter	In Concrete	In Grouted Masonry	
3/8 inch	2 1/2 inch	2 5/8 inch	8 inch
1/2 inch	3 1/2 inch	3 1/2 inch	8 inch
5/8 inch	4 1/2 inch	4 1/2 inch	10 inch
3/4 inch	5 inch	5 1/4 inch	12 inch

E. Flush shell anchors:
   1. Not permitted in the Work.
   2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact the Engineer for instructions before proceeding.

F. Sleeve anchors:
   1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Sleeve Anchors			
	Minimum Effective Embedment Length		Minimum Member Thickness
Nominal Diameter	In Concrete	In Grouted Masonry	
M8 (1/2 inch)	70 mm (2 3/4 inch)	Not accepted	100 mm (8 inch)
M10 (5/8 inch)	76 mm (3 inch)	Not accepted	250 mm (10 inch)
M12 (3/4 inch)	80 mm (3 1/4 inch)	Not accepted	300 mm (12 inch)

   2. Install with the sleeve fully engaged in the base material.

G. Screw anchors:
   1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Screw Anchors			
	Minimum Effective Embedment Length		Minimum Member Thickness
Nominal Diameter	In Concrete	In Grouted Masonry	
3/8 inch	2 1/2 inch	3 1/4 inch	8 inch
1/2 inch	3 1/4 inch	4 1/2 inch	8 inch
5/8 inch	4 inch	5 inch	10 inch
3/4 inch	5 1/2 inch	6 1/4 inch	12 inch

2. Install using equipment and methods recommended by the manufacturer. Continue driving into hole until the washer head is flush against the item being fastened.

H. Undercut concrete anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Undercut Anchors			
Nominal Diameter (bolt)	**Minimum Effective Embedment Length**		**Minimum Member Thickness(1)**
	In Concrete	**In Grouted Masonry**	
M10 (3/8 inch)	100 mm (4 inch)	Not accepted	200 mm (8 inch)
M12 (1/2 inch)	125 mm (5 inch)	Not accepted	350 mm (14 inch)
M16 (5/8 inch)	190 mm (7 1/2 inch)	Not accepted	460 mm (18 inch)
M20 (7/8 inch)	250 mm (10 inch)	Not accepted	510 mm (20 inch)

Notes:

(1) Thickness indicated is for pre-set units. If through-set units are accepted, obtain minimum member thickness requirements from the Engineer.

2. Installations of undercut anchors shall not be allowed where edge distances are less than 12 times the nominal diameter of the anchor stud.
3. Undercut bottom of hole using cutting tools manufactured for this purpose by the manufacturer of the undercut anchors being placed.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01450 - Quality Control.
1. Expenses associated with Work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
3. Certify in writing that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner's representative will provide on-site observation and field quality assurance for the Work of this Section.
1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted Submittals, and the manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to the Engineer upon request.
   3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
      b. Anchor rods.
      c. Welded studs.
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel or Type 316 stainless steel, as specified in this Section or indicated on the Drawings.
         3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
         4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
   3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
      a. Base material (concrete or grouted masonry):
         1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
         2) Material encapsulating embedment is dense and well-consolidated.

D. Special inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
      b. Sleeve anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors.
      a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.
   3. Requirements for periodic special inspection:
      a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and

size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new "initial inspection."

b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor's rated strength.

c. Anchor:
1) Manufacturer, type, and dimensions (diameter and length).
2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).

d. Hole:
1) Positioning: Spacing and edge distances.
2) Drill bit type and diameter.
3) Diameter, and depth.
4) Hole cleaned in accordance with the manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
5) Anchor's minimum effective embedment.
6) Anchor tightening/installation torque.

4. Requirements for continuous special inspection:
a. Special inspector shall observe all aspects of anchor installation, except that holes may be drilled in their absence provided that they confirm the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
1. Owner's Representative may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.08 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.09 SCHEDULES

A. Provide and install anchor materials as scheduled in the following table.

Required Anchoring Materials by Location				
Location/Exposure			**Materials**	**Notes**
1.	**Anchors into concrete and grouted masonry for attachment of carbon steel, including structural steel and other steel fabrications:**			
	a.	Interior dry areas	Carbon steel - galvanized	
	b.	Locations with galvanized steel structures or fabrications	Stainless steel - Type 304 or 316	1
	c.	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
	d.	Corrosive locations	Stainless steel - Type 316	1
2.	**Anchors into concrete and grouted masonry for attachment of aluminum, stainless steel, or fiber-reinforced plastic (FRP) shapes and fabrications:**			
	a.	Interior dry areas	Stainless steel - Type 304 or 316	1
	b.	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
	c.	Corrosive locations	Stainless steel - Type 316	1
3.	**Anchors for attaching equipment and its appurtenances:**			
	a.	All locations	Stainless steel - Type 316 (unless Type 304 is specifically indicated in the specifications for the equipment.)	1

Notes:

(1) Where anchors are in contact with a metal that differs from that of the anchor, provide isolation sleeves and washers.

END OF SECTION

SECTION 05216

OPEN WEB STEEL JOIST FRAMING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Open web steel joists, joist girders, and accessories.
   2. Welding and bolts for connections at joists and joist girders.

1.02 REFERENCES

A. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Non-Destructive Examination.
   2. D1.1 - Structural Welding Code - Steel.

B. ASTM International (ASTM):
   1. A123 -Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Irons and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   4. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   5. E709 - Standard Guide for Magnetic Particle Testing.
   6. F436 - Standard Specification for Hardened Steel Washers.
   7. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts and Special Threaded Fasteners.
   8. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

C. Occupational Safety and Health Administration (OSHA):
   1. Code of Federal Regulations (CFR), Title 29 - Labor, Chapter XVII.
      a. Part 1926.757 - Steel Erection; Open Web Steel Joists.

D. Society for Protective Coatings (SSPC):
   1. Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
   2. SP-15 - Commercial Grade Power tool Cleaning.

E. Steel Joist Institute (SJI):
   1. Code of Standard Practice:
      a. COSP - Code of Standard Practice for Steel Joists and Joist Girders.
   2. Standard Specifications:
      a. K Series - Standard Specifications for Open Web Steel Joists.

b. LH/DLH Series - Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series.
c. JG Series - Standard Specification for Joist Girders.

3. Standard Load Tables:
   a. Standard Specification Load Tables and Weight Tables for Steel Joists and Joists Girders.
4. Technical Digests:
   a. TD 8 - Welding of Open-Web Steel Joists and Joist Girders.
   b. TD 9 - Handling and Erection of Steel Joists and Joist Girders.

1.03 TERMINOLOGY

A. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. SJI Standard Specifications: Refers to one or more of the following documents corresponding to the joist type indicated on the Drawings:
      a. K Series - Standard Specifications for Open Web Steel Joists.
      b. LH/DLH Series - Standard Specifications for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series.
   2. SJI Standard Load Tables: Refers to one of the following documents corresponding to the joist type indicated on the Drawings:
      a. Standard Load Tables, Open Web Steel Joists, K-Series (LRFD & ASD).
      b. Standard Load Tables, Longspan Steel Joists, LH-Series (LRFD and ASD).
   3. Steel joists: As referred to in this Section, includes joists, K series joist substitutes, joist girders, and joist headers.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer’s specifications and installation instructions for each type of joist and accessories.
   2. Coatings:
      a. Shop coating: Manufacturer’s product data sheets indicating type and characteristics of applied coatings, and recommendations for preparation and materials for finished coatings.
      b. Galvanizing: Galvanizing contractor’s information regarding procedures for hot-dip galvanizing and for inspecting and repairing coatings.

C. Shop Drawings:
   1. General:
      a. Provide fabrication drawings/schedules, and erection/layout drawings for joists and related miscellaneous metal work.
      b. Clearly indicate portion of the Work covered by each Submittal, and location of each member in the work.
      c. Mark number or tags on joists and fabrications shall be the same mark numbers indicated on fabrication schedules and erection drawings.
      d. Indicate shop and field welds using symbols in accordance with AWS A2.4. Indicate net weld lengths.

2. Fabrication drawings/schedules:
    a. Detail each piece or assembly to be incorporated into the work.
    b. For each joist type and size, and for each accessory, indicate:
        1) SJI standard designations including depth and chord size.
        2) Identification mark number.
        3) Loading criteria and camber.
        4) Configuration and details including joist elevation view; bearing seats; end conditions; chord extensions; and details of internal joints, welds, and splices (if any).
        5) Dimensions, both overall and internal.
        6) Methods of connecting, anchoring, fastening, bracing, bridging, and attaching.
        7) Coatings and surface preparation.
3. Erection/layout drawings:
    a. Indicate placement of each piece shown in the fabrication drawings/schedules or listed in the bill of materials.
    b. Show layout of joists with mark numbers; methods of framing at openings; locations, types, and connection details for bridging; details of connections between joists and supporting joist girders, joist headers, framing, or structures; and accessories.
    c. Indicate erection sequence and requirements for temporary bracing.
    d. Show requirements for field welding and bolting.
    e. Show profiles and deflection criteria under live and total loads for joist configurations not specifically listed in SJI Standard Load Tables.
    f. List loads used in the design of steel joists.
        1) Show loads and position of loads from mechanical and electrical equipment supported by the joists and framing.

D. Calculations:
1. Submit calculations for each joist type and span, documenting adequacy to resist uniform and concentrated loads indicated on the Drawings; locations, sizes and types of bridging for resisting downward and uplift loads; and adequacy of connections of joists and bridging.
2. Provide calculation cover letter sealed and signed by the joist manufacturer's qualified registered design professional licensed in the state where the Project is located.

E. Certificates/certifications:
1. SJI membership: Submit evidence of manufacturer's current membership in SJI and of manufacturer's qualifications to produce members of the types specified and required for the Work.
2. SJI compliance: At the completion of manufacturer, for each joist type and load case provided, submit manufacturer's certificate of compliance stating that design and fabrication of members was performed in accordance with SJI Standard Specifications and the approved Shop Drawings. Include manufacturer's statements that:
    a. Welders performing shop welding for joists hold current qualification for the types of welding and welding positions required for the Work.
    b. Manufacturer has completed in-plant before shipment to verify compliance of materials and workmanship with the requirements of SJI Standard Specifications for the products produced.

3. Quality control program: Submit evidence of active participation in a nationally recognized program for quality control of steel fabrication.
4. Field welding: Submit welder qualification certificates in accordance with AWS D1.1 for the types of welding and welding positions required for the Work.

F. Test and inspection reports:
1. Mill test reports: Submit manufacturer's certificates, indicating ASTM standards, structural strength, and material properties for steel used in the joists and bridging.
2. Inspections:
a. Source quality control.
1) Submit reports of manufacturer's in-plant inspections for compliance with SJI Standard Specifications.
b. Field quality control:
1) Submit Installation and Welding Inspection Report as specified in Attachment A - Installation and Welding Inspection Report.

1.05 QUALITY ASSURANCE

A. Design and fabricate joists in compliance with the following and as specified in this Section:
1. SJI Standard Specifications.
2. SJI Standard Load Tables.
3. SJI Code of Standard Practice.

B. Qualifications:
1. Manufacturers:
a. Holding current membership in the Steel Joist Institute and a recognized fabricator of structural steel joists conforming to the SJI Standard Specifications, the SJI Standard Load Tables, and the SJI Code of Practice.
2. Installer/Erector:
a. Field welding: Qualified procedures and welders in accordance with AWS D1.1. Provide welders qualified within the last 12 months preceding the date of joist erection.

C. Regulatory requirements:
1. In accordance with OSHA requirements for steel erection, including specific requirements for joists and framing.

D. Inspection:
1. Inspect joists in accordance with SJI Standard Specifications.
2. Inspect fabrication as specified in Part 2, Source Quality Control.
3. Provide inspections for Field Quality Control and Field Quality Assurance as specified in Part 3, Execution.

E. Pre-installation conference: Steel joists and deck.
1. Coordinate with the requirements of Section 05310 - Steel Deck.
2. Schedule and conduct pre-installation conference at least 2 weeks prior to installation of joists.
a. Provide additional conferences if necessary to discuss or coordinate specific conditions of installation.

3. Required attendees:
    a. Contractor.
    b. Steel joist manufacturer's technical representative.
    c. Steel joist installer's job superintendent.
    d. Subcontractor(s) providing and installing coatings under Division 9.
4. Agenda:
    a. Joist Submittals.
    b. Deck placing and fastening procedures.
    c. Manufacturer's recommended inspections and inspection procedures.
    d. Requirements and coordination for quality control inspections and quality assurance (including special inspections).
    e. Other Specification requirements requiring coordination between parties to the Work.
5. Prepare and submit minutes of the pre-installation conference as specified in Section 01312 - Project Meetings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Transport, deliver, store, and handle steel joists as recommended in SJI specifications, and as required to avoid stresses and to prevent damage to materials and coatings.

B. Observe delivered materials for damage before and after unloading, and note any permanent bends, deformations, broken welds, or other damage on the receiving documents.

C. Store joists off the ground, protected from weather and corrosion, and under watertight covering sloped to drain.
    1. Support by means that will protect members from distortion and damage.
    2. Store joists with top chord down and with plane of joist vertical.

1.07 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Special warranty:
    1. Duration: 5 years warranty on joists.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Pre-engineered, prefabricated, open-web steel joists, joist girders, and accessories designed and fabricated to the requirements of the Steel Joist Institute and details as specified in this Section and indicated on the Drawings.

B. Design requirements:
    1. Design joists and bridging in accordance with current SJI Specifications and load tables to support loads indicated based on the depth, spacing, and deflections, indicated.
        a. Maximum deflection under live load:
            1) Roof joists: Span divided by 360.
        b. Minimum design loads as indicated on the Drawings:
            1) Dead load.
            2) Live load.
            3) Snow load.
            4) Wind load (net uplift).
            5) Axial tension and compression forces applied to the truss at end connections.
        c. Camber: Provide standard camber based on SJI Standard Specifications unless otherwise indicated on the Drawings.
            1) In no case shall joists be manufactured with negative (downward) camber.
            2) Where a joist will be installed parallel to and within 6 feet of a wall, decrease camber in that joist nearest the wall to one-half of the standard camber.
    2. Joist chord extensions:
        a. Top chord extensions. Capable of withstanding the loads indicated for the joist plus any concentrated loads indicated. Brace to prevent lateral torsional buckling of the extension under loads.
        b. Bottom chord extensions. Capable of supporting weight of ceilings or other items indicated. Extending to within 1 inch of interior finished wall surface unless otherwise indicated on the Drawings.
    3. Bridging: Provide horizontal and diagonal bridging as required by the SJI Standard Specifications, as indicated on the Drawings, and as required to maintain stability under gravity, uplift, erection, and construction loadings.
    4. End anchorage: Provide end anchorage details to secure and/or stabilize joists at supports, and to transfer any loads indicated on the Drawings.
    5. Header units: Provide header units to support joists at openings in floor or roof framing not framed with structural steel shapes.
    6. Accessories:
        a. Provide miscellaneous items including splice plates, reinforcing angles, and bolts required to complete the installation.
        b. Provide supplemental steel framing to support steel deck where normal deck bearing is precluded by other framing members and minor openings.

2.02 MATERIALS

A. Steel joists:
    1. Provide joist type, chord configuration, depth, and bearing as indicated on the Drawings.
    2. Comply with SJI Standard Specifications for joist series indicated.
    3. Details: Provide the following.
        a. Chord members: Rolled double angle sections only. Rod or bar members are not permitted.

b. Chord extensions: Joists.
    1) Bottom chord ("ceiling") extensions**:** Where indicated on the Drawings**.**
    2) Top chord extensions: "S-Type" or "R-Type" as indicated on the Drawings.
c. Chord extensions: Joist girders.
    1) Joist girder bottom chord extension with vertical slip connection at and stabilizer plate that is fastened to supporting structure.

B. Bridging:
1. In accordance with SJI Standard Specifications for type of joist, chord size, spacings, spans and uplift loads indicated on the Drawings.
2. Anchored to walls, girders, and roof deck as indicated.

C. Coatings:
1. Shop paint. In accordance with SSPC Paint 15.

D. Fasteners:
1. Anchor bolts and anchor rods to concrete and masonry: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
2. Bolts: Pre-tensioned bolted connections.
    a. Provide high-strength bolt assembly with hardened flat washers and nuts. Provide uncoated components unless galvanized coating is indicated on the Drawings.
    b. Uncoated:
        1) Bolts: Plain, heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1.
        2) Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
        3) Washers: Circular flat washers in accordance with ASTM F436.

E. Accessories:
1. Bearing plates: As specified in Section 05120 - Structural Steel Framing.

2.03 FABRICATION

A. Open web steel joists:
1. Fabricate steel joist in accordance with SJI Standard Specifications to details indicated on the Drawings.

B. Cross bridging: Provide horizontal or diagonal type bridging for joists.

C. End anchorage: Provide end anchorage, including bearing plates, to secure joists to adjacent construction as indicated on the Drawings.

D. Coatings:
1. Shop primer:
    a. Clean and prime joists and accessories in accordance with SSPC Paint 15.

b. After delivery, remove shipping primer and prepare joists and accessories for re-priming and finish coating specified in Section 09960 - High-Performance Coatings.

2.04 SOURCE QUALITY CONTROL

A. Tests and inspections:
   1. Provide joist manufacturer's inspection as required by SJI Standard Specifications. Submit inspection results.
   2. Special Inspection - Fabrication. Requirements of the building code specified in Section 01450 - Regulatory Requirements for special inspection of fabricated structural items shall be considered to be satisfied when the manufacturer is registered and approved to perform steel fabrication work in accordance with a quality control program that is certified by the Steel Joist Institute (SJI), the American Institute of Steel Construction (AISC), the City of Los Angeles Department of Building and Safety (COLA), or similar program acceptable to building official and the Engineer.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and erect steel joists accordance with the requirements of SJI's Code of Standard Practice for Steel Joists and Joist Girders.

3.02 PREPARATION

A. Field verify dimensions and elevations of structural elements supporting the joists and joist girders.
   1. Establish lines and elevations within tolerances before beginning erection.
   2. Make bearing surfaces true and uniform.
   3. Do not begin placement of steel joists until supporting work is in place and secured.

B. Clean bearing surfaces of joists and supporting members before erection and as required during erection to maintain solid contact between members.

C. Do not permit erection of steel deck until joists are connected and bridging is in place.

3.03 INSTALLATION

A. Erection:
   1. Place and secure steel joists in accordance with SJI Standard Specifications, approved erection drawings, and these Specifications.
   2. Allow for loads from erection procedures, but do not load joists until fastening is complete.
   3. Provide sufficient temporary bracing to maintain joists and supporting framing safe, plumb, and in true alignment until completion of erection and installation of permanent bridging and bracing.

B. Installation of joists and bridging:
   1. Do not start placement of steel joists until supporting work is in place, adjusted to specified tolerances, and secured.
   2. Do not field modify, alter, or repair joists unless specific written instructions have been received from the joist manufacturer and submitted to the Engineer. Such instructions shall bear the seal and signature of the joist manufacturer's registered design professional licensed in the state where the joists are installed.
   3. Place joists on supporting surfaces, adjust, and accurately align to required elevation, location and spacing before permanently fastening.
      a. Set joists plumb and level (with indicated allowances for camber).
      b. Set "tag end" of joists at location shown on the erection plans.
      c. Adjust bearing shoe elevations to provide full bearing after joists and supporting members have been plumbed and positioned, but before final tightening of connections and before any loads are imposed.
      d. Solidly pack areas under bearing plates using materials and procedures indicated on the Drawings.
   4. Install bridging in accordance with OSHA 29 CFR-1926.757d and SJI Standard Specifications to provide lateral stability for the joists before slacking of hoisting lines. Quantity of bolted diagonal erection bridging shall be in accordance with SJI Standard Specifications.
   5. Install bridging simultaneously with joist erection and before construction loads are applied. Anchor ends of bridging lines at top and bottom chords where terminating at walls or beams. Quantity, size, and sequence for installing bridging shall be in accordance with SJI Standard Specifications.
   6. Erection stability and handling shall be in accordance with SJI Standard Specifications.

C. Fastening joists:
   1. Each joist must be attached at a minimum of one end immediately upon placement in the final erection position and before additional joists are placed.
   2. When field welding joists, weld to supporting steel framework in accordance with SJI Standard Specifications and as indicated on the Drawings.
      a. Coordinate welding sequence and procedure with placing of joists.
      b. In accordance with AWS D1.1.
      c. Length of field welds applied to the top and bottom chords of joists shall not exceed 1/2 of the width of the steel member.
   3. When bolting joists, bolt to supporting steel framework in according with SJI Standard Specifications.

D. Coating:
   1. Deliver joists coated or uncoated as indicated on the Drawings and specified.
   2. Where members are painted or coated in place, do not begin preparation or coating until units are in place; properly, completely, and permanently fastened, and accepted by the Engineer.
   3. Prepare, prime, and finish as specified in Section 09960 - High-Performance Coatings.
   4. Perform surface preparation and coating application under environmentally controlled field conditions, or in an off-site paint shop.

3.04 TOLERANCES

A. As indicated in SJI Standard Specifications, unless otherwise noted.

B. Deviation from straight line between opposite ends of any installed joist: Maximum 3/8 inch in 10 feet.

3.05 REPAIR

A. Do not install damaged joists or accessories. Remove such materials from the site and replace with sound materials at no additional cost to the Owner.

B. Repair rust spots and coatings damaged by handling, welding, or other erection and fastening processes.

C. After erection, touch-up rust spots, connections, field welds, and abraded areas of members using specified coatings.
   1. Clean and prepare damaged areas.
   2. Apply coating at the same thickness as that applied before erection.
   3. Feather edges of repairs to provide a uniform appearance after repair.
      a. Clean and prepare surfaces using SSPC-SP 15 procedures.
      b. Apply coating of same product and color as member. Apply primer and finish coat(s).

D. Galvanized surfaces: Repair in accordance with ASTM A780.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as required by Section 01450 - Regulatory Requirements.

B. Field tests and inspections:
   1. High-strength bolting:
      a. Confirm use of specified bolts and nuts.
      b. Pre-tensioned connections:
         1) Confirm that plies of the connected elements have been brought into firm contact by the tightened connection.
         2) Confirm bolts pretension using turn-of-the nut method, twist-off type tension controlled nut, or direct-tension indicator washer. Do not use calibrated wrench.
   2. Welding - Field welds.
      a. Perform observations and testing in the presence of the Engineer.
      b. Visual observation:
         1) Visually examine welds in accordance with AWS D1.1.
         2) Quality of welds and standards for acceptance shall be in accordance with AWS D1.1, “Visual Inspection Acceptance Criteria” Table.
      c. Test results:
         1) Submit records of testing to the Engineer within 24 hours after testing.
   3. After erection, observe installation for conformance with this Specification.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as required by Section 01450 - Regulatory Requirements.

B. Special inspections, special tests and structural observation:
   1. Provide as required by Section 01455 - Regulatory Quality Assurance.

C. Field inspections:
   1. Required inspections:
      a. Observe construction for conformance to the Contract Documents and the accepted Shop Drawings.
         1) Confirm that joist and accessory locations and tags (marks) match those indicated on the erection drawings.
         2) Confirm that joists are installed in vertical alignment and without lateral sweep.
         3) Confirm that joist spacing conforms to erection drawings.
         4) Confirm that bridging lines, spacing, and connections/anchoring conform to erection drawings.
      b. Visually inspect field bolting, including bolt tightness.
      c. Visually inspect field welding using AWS certified welding inspectors in accordance with AWS D1.1.
         1) In accordance with AWS D1.1.
         2) Mark welds observed.
   2. Records of inspections:
      a. Provide record of each inspection.
      b. Submit copies to the Engineer upon request.

D. Field testing.

3.08 NON-CONFORMING WORK

A. Remove and replace damaged and non-conforming work to the satisfaction of the Engineer.

END OF SECTION

ATTACHMENT A - INSTALLATION AND WELDING INSPECTION REPORT

INSTALLATION AND WELDING INSPECTION REPORT

Project:			
Client:			
Permit No.:		**Structure:**	
Contractor:			
Date:		**Weather:**	
Weather:		**Temp (min/max):**	
Dwg. Ref:			
Location:			

ELEMENTS INSPECTED	**REF[(1)]**	**CONFORMS?**		
		Yes	**No**	**Comments[(2)]**
Member Installation:				
Joist and accessory locations, tags, and tagged end locations conform to erection drawings.	1			
Joist spacing conforms to erection drawings.	1			
Joists and accessories are installed in horizontal and vertical alignment and without lateral sweep.	1			
Joist bearing length on supporting members conforms to erection drawings and details.	1a			
Joist and accessory installations conform to specified tolerances.				
Bridging:				
Bridging locations, types (horizontal or diagonal), and member sizes conform to erection drawings.	1b			
Bridging connections to joists conforms to erection drawings.	1b			
Bridging connections to and terminations at ends/walls conforms to erection drawings.	1b			
Field Welding:				
Welds at locations indicated on erection drawings.				
Weld size and length as indicated on erection drawings.	1a			
Quality of welds complies with AWS D1.1 - “Visual Inspection Acceptance Criteria” Table	1a			

(Continued, next page)

ELEMENTS INSPECTED	REF[1]	CONFORMS?		
		Yes	No	Comments[2]
Field Bolting:				
Bolts at locations indicated on erection drawings.	1a			
Bolts, nuts and washers of sizes and materials specified.	1a			
Bolts tightened as specified. All plies of connection have been brought into firm contact.	1a			
Other:				

Notes:

(1) Reference: 2015 IBC Table 7105.2.3.
(2) Comments: Insert comment number from page 2 this form.

Comments:

Inspector:

Name (printed): _____

Signature: _____ Date: _____

Company (printed): _____

SECTION 05310

STEEL DECKING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel deck for floors and roofs, and associated accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

B. American Welding Society (AWS):
   1. D1.3 - Structural Welding Code - Sheet Steel.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Store steel deck at the site stacked on platforms or pallets and covered with tarpaulins or other suitable weathertight covering.
   2. Do not use steel deck for storage or working platform.
   3. Remove damaged, unlabeled, untagged, rusty, and deteriorated steel deck material from the job site.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. ASC Profiles.
   2. Verco Manufacturing Co.
   3. Nucor Vulcraft Group.

2.02 MATERIALS

A. Sheet steel: ASTM A653, G 90 minimum coating designation.

2.03 FABRICATION

A. Steel deck shall be formed:
   1. So every sheet is identical and will register perfectly with adjacent sheets.
   2. In accordance with building code as specified in Section 01410- Regulatory Requirements.

B. Decking used with concrete fill shall be deformed to develop composite action between the deck and the concrete.

C. Furnish minimum gauge, deck thickness, section modulus, moment of inertia, and allowable diaphragm shear per foot of deck width that is not less than for type deck sections indicated on the Drawings.

D. Treat exposed roof deck with phosphate.

E. Furnish roof deck ready to receive field painting without further pretreatment. Paint exposed roof deck in accordance with Contract Documents.

F. Accessories:
   1. Furnish all accessories indicated on the Drawings or needed to completed work.
   2. Minimum required gauges:
      a. Sump pans: 14 gauge.
      b. All other accessories: 20 gauge unless otherwise indicated on the Drawings.

G. Welding and electrodes: In accordance with AWS D1.3.

H. Furnish roof decking in lengths to minimize number of splices.

I. Furnish steel deck complete, including cutting, shaping, fitting, drilling, welding, ridge plates, valley plates, reinforcing plates for openings, and miscellaneous pieces necessary for proper installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine work in place to verify that it is satisfactory to receive the work of this Section. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. Decking shall span over at least 3 spans wherever possible.

B. Do not damage or overload roof deck during installation.

C. Do not use steel deck for storage or as a working platform until sheets have been welded in position.

D. Do not exceed maximum uniformly distributed load of 20 pounds per square foot.

E. Install decking in straight and continuous rows as far as practicable, with ribs at right angles to supporting members.

F. For each end of deck section, provide 3 inches minimum bearing on supports. For sections that abut each other, each piece shall bear a minimum of 3 inches on the support. This requires a 6 inch minimum flange width. For cases where the minimum bearing cannot be obtained, notify the Engineer.

G. Electric arc weld deck sections to bearing plates, supports at butt joints, at intermediate supports, side supports, and at end supports as indicated on the Drawings. Do not burn through the deck. Remove all slag.

H. Fasten the longitudinal joints between deck sections together by the method indicated on the Drawings.

I. Neatly cut and fit openings in roof deck, and reinforce with structural steel members as indicated on the Drawings.

J. Paint welds as specified.

K. Install roof deck free of dents and bent members.

L. Reinforce all holes and openings in steel deck as indicated on the Drawings.

M. Piping, conduit, equipment, and other services: Do not hang from decking.

N. Install all accessories required to complete work.

3.03 REPAIR OF GALVANIZING AND COATING

A. Touch-up damage to galvanized surfaces, including cut edges and holes, with zinc rich primer.

B. Repair damage to factory-applied coating system in accordance with the manufacturer's printed recommendations.

3.04 CLEANUP

A. After erection, remove weld spatter, grease, and oil from decking.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Concrete inserts.
   5. Handrails and guardrails.
   6. Ladders.
   7. Manhole frames and covers.
   8. Metal gratings.
   9. Metal tread plate.
   10. Preformed channel pipe supports.
   11. Stairs.
   12. Overhead Supported Canopies & Covered Walkway.
   13. Miscellaneous metals.
   14. Associated accessories to the above items.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45: Designations from Start to Finish.
      a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

C. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   9. A489 - Standard Specification for Carbon Steel Lifting Eyes.

10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. A635 - 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.
13. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. A992 - Standard Specification for Structural Steel Shapes.
15. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
20. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

D. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

E. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product Data:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Handrails and guardrails.
   5. Manhole frames and covers.
   6. Metal grating.

B. Shop drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.

b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
c. Include erection drawings, elevations, and details where applicable.
d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

2. Ladders.
3. Metal grating.
4. Metal tread plate.
5. Stairs.
6. Overhead Supported Canopies & Covered Walkways.
7. Miscellaneous metals.

C. Samples:
1. Guardrails with specified finishes.

D. Quality control submittals:
1. Design data.
2. Test reports:
a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current State and OSHA strength requirements.
b. Gratings:
1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A48	Class 40B
Steel		
Galvanized sheet iron or steel	A653	Coating G90
Coil (plate)	A635	--

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Structural plate, bars, rolled shapes, and miscellaneous items (except W shapes).	A36	--
Rolled W shapes	A992	Grade 50
Standard bolts, nuts, and washers	A307	--
High strength bolts, nuts, and hardened flat washers	F3125, Grade A325	--
Eyebolts	A489	Type 1
Tubing, cold-formed	A500	--
Tubing, hot-formed	A501	--
Steel pipe	A53	Grade B
Stainless Steel		
Plate, sheet, and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**
Bolts (Type 304)	F593	Group 1 Condition CW
Bolts (Type 316)	F593	Group 2 Condition CW
Aluminum		
Flashing sheet aluminum	B209	Alloy 5005-H14, 0.032 inches minimum thickness
Structural sheet aluminum-	B209	Alloy 6061-T6
Structural aluminum	B209 B308	Alloy 6061-T6
Extruded aluminum	B221	Alloy 6063-T42

* Use Type 304L if material will be welded.
** Use Type 316L if material will be welded.

1. Stainless steels are designated by type or series defined by ASTM.
2. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MANUFACTURED UNITS

A. Aluminum grating stair tread:
   1. Manufacturers: One of the following or equal:
      a. Harsco Industrial IKG, Aluminum Grating Stair Tread with Mebac® nosing.
      b. McNichols Co., Type A-Standard with Corrugated Angle Nosing.
   2. Material: Welded aluminum grating tread with non-slip nosing and integral end plates for bolt on attachment to stair stringers.
   3. Size:
      a. Tread width: To equal tread spacing plus 1 inch minimum.
      b. Tread length: Length to suit stringer-to-stringer dimension on the Drawings.
      c. Depth: 1-3/4 inches.
   4. Bolts: Type 316 stainless steel.

B. Aluminum stair nosing:
   1. Manufacturers: One of the following or equal:
      a. Wooster Products, Inc., Type 101 Nosing.
      b. American Safety Tread Co., Inc., Style 801 Nosing.
   2. Material: Cast aluminum abrasive nosings with aluminum oxide granules integrally cast into metal, forming permanent, nonslip, long-wearing surface.
   3. For installation in cast-in-place stairs.
   4. Configuration: 4 inches wide, fabricated with integrally cast stainless steel anchors at approximately 12-inch centers. Length to extend within 3 inches of stair edge on each side.

C. Cast iron stop plank grooves:
   1. Manufacturers: One of the following or equal:
      a. Neenah Foundry Co., R-7500 Series, Type A.
      b. McKinley Iron Works, Type L.
   2. Size: 2-inch wide groove opening by 1-1/2 inch deep, unless otherwise indicated on the Drawings.
   3. Recess groove with the cast iron surface of the groove set flush with the concrete surface.

D. Concrete inserts:
   1. Concrete inserts for supporting pipe and other applications are specified in Section 15061 - Pipe Supports.

E. Handrails and guardrails:
   1. General:
      a. Design and fabricate assemblies to conform to current local, State, and OSHA standards and requirements.
      b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
         1) Indicate on the shop drawings locations of such equipment.

2) Highlight locations where railings cannot be made continuous, and obtain Engineer's directions on how to proceed before fabricating or installing railings.

2. Aluminum handrails and guardrails (nonwelded pipe):
   a. Rails, posts, and fitting-assembly spacers:
      1) In accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
   b. Kick plates: 6061 or 6105 aluminum alloy.
   c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
   d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
      1) Fabrications: In accordance with ASTM B209 or ASTM B221 extruded bars:
         a) Bases: 6061 or 6063 extruded aluminum alloy.
      2) Plug screws or blind rivets: Type 305 stainless steel.
         a) Other parts: Type 300 series stainless steel.
   e. Finish of aluminum components:
      1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
      2) Pretreat aluminum for cleaning and removing markings before anodizing.
   f. Fabrication and assembly:
      1) Fabricate posts in single, unspliced pipe length.
      2) Perform without welding.
      3) Do not epoxy bond the parts.
      4) Maximum clear opening between assembled railing components as indicated on the Drawings.
   g. Manufacturers: One of the following or equal:
      1) Moultrie Manufacturing Co., Wesrail.
      2) Golden Railings, Riveted System.
      3) Craneveyor Corp. Enerco Metals, C-V Rail.
3. Fastenings and fasteners: As recommended or furnished by guardrail manufacturer for use with this system.

F. Ladders:
   1. General:
      a. Type: Safety type conforming to local, State, and OSHA standards as minimum. Furnish guards for ladder wells.
      b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.
   2. Aluminum ladders:
      a. Materials: 6063-T5 aluminum alloy.
      b. Rungs:
         1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
         2) Capable of withstanding 1,000 pound load without failure.
      c. Side rails: Minimum 4-inch by 1/2-inch flat bars.

d. Finish of aluminum components:
    1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
    2) Pretreat aluminum for cleaning and removing markings before anodizing.
e. Fabrication:
    1) Welded construction, of size, shape, location, and details indicated on the Drawings.
    2) For ladders over 20 feet high, furnish standard ladder cages or fall prevention system designed in accordance with State and OSHA requirements.
f. Fall prevention system: Include but not limit to railing, brackets, clamps, 2 sleeves, and 2 belts, satisfying OSHA safe climbing requirements:
    1) Manufacturers: One of the following or equal:
        a) North Consumer Products, Saf-T-Climb.
        b) Swager Communications, Climbers Buddy System.

G. Manhole frames and covers:
1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
4. Frame:
    a. Bottom flange type.
    b. Approximately 4-1/2 inches frame height.
    c. Dimensions as indicated on the Drawings.
        1) Minimum inside clear dimension may not be smaller than nominal diameter minus 2 inches.
5. Cover:
    a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as "ELECTRICAL," "SEWER," "TELEPHONE," or "WATER."
    b. Solid type without ventilation holes.
6. Finish: Unpainted.

H. Metal gratings:
1. General:
    a. Fabricate grating to cover areas indicated on the Drawings.
    b. Unless otherwise indicated on the Drawings, grating over an opening shall cover entire opening.
    c. Make cutouts in grating where required for equipment access or protrusion, including valve operators or stems, and gate frames.
    d. Band ends of grating and edges of cutouts in grating:
        1) End banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
        2) Cutout banding: Full height of grating.
        3) Use banding of same material as grating.

4) Panel layout: Enable installation and subsequent removal of grating around protrusions or piping.
5) Openings 6 inches and larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
6) Openings smaller than 6 inches: Locate opening at edge of single panel.
7) Where an area requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4-points with fasteners acceptable to Engineer.
8) Fabricate steel grating sections in units weighing not more than 50 pounds each.
9) Fabricate aluminum grating sections in units weighing not more than 50 pounds each.
10) Gaps between adjacent grating sections shall not be more than the clear spacing between bearing bars.

e. When requested by Engineer, test 1 section of each size grating for each span length involved on the job under full load:
1) Furnish a suitable dial gauge for measuring deflections.

f. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings.

2. Aluminum grating:
a. Material for gratings, shelf angles, and rebates: 6061-T6 or 6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum alloy.
b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
d. Bar size and spacing: As determined by manufacturer to enable grating to support design load.
e. Design live load: A minimum of 100 pounds per square foot uniform live load on entire grating area, but not less than the live load indicated on the Drawings for the area where grating is located.
f. Maximum fiber stress for design load: 12,000 pounds per square inch.
g. Maximum deflection due to design load: 1/240 of grating clear span.
h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
i. Minimum grating height: 1-1/2 inches.
j. Manufacturers: The following or equal:
1) Harsco Industrial IKG, Swaged Aluminum I-Bar with striated finish.

3. Heavy-duty steel grating:
a. Heavy-duty type, fabricated from structural steel and designed in accordance with AASHTO Standard Specifications for Highway Bridges, using H-20 loading.
b. Hot-dip galvanized after fabrication in accordance with ASTM A123.
c. Manufacturers: One of the following or equal:
1) Reliance Steel Products Co., Heavy-Duty Steel Grating.
2) Seidelhuber Metal Products, Inc., equivalent product.

I. Metal tread plate:
1. Plate having a raised figured pattern on 1 surface to provide improved traction.

J. Preformed channel pipe supports:
   1. Preformed channel pipe supports for pipe supports and other applications are specified in Section 15062 - Preformed Channel Pipe Support System.

K. Stairs:
   1. Aluminum stairs:
      a. Stringers: 6061-T6 aluminum alloy.
      b. Stair treads:
         1) Aluminum of same type specified under Aluminum Grating.
         2) Of sizes indicated on the Drawings, and 1-3/4 inch minimum depth with cast abrasive type safety nosings.
      c. Handrails and guardrails: Aluminum pipe specified under Aluminum Handrails and Guardrails (Nonwelded Pipe).
      d. Fasteners: Type 304 or Type 316 stainless steel.

L. Aluminum Overhead Supported Canopies and Covered Walkways:
   1. Minimum 5 years' experience in design, fabrication, and production of aluminum canopies and cover systems. Manufacturer must submit complete designed canopy system details, sizes, and strengths for acceptance.
   2. The canopy frame shall be made water-tight and sloped to shed standing water. Crimped decking is not allowed.
   3. Canopies and covered walkways shall drain from the decking to a perimeter gutter system and discharge from the gutter to a drain. For overhead canopies, a downspout may be used to drain from the canopy to the ground as indicated on the Drawings.
   4. Design load: Dead load of the canopy. A minimum of 20 pounds per square foot uniform live load on entire canopy area. Other load minimums (i.e. rain, snow, and wind) as indicated on the Drawings.
   5. Decking, frame and supports: 6063-T6 extruded aluminum.
   6. Hanger rods: A36 steel with clevis and rod selected by the manufacturer.
   7. Anchorage into CMU Wall: SS threaded anchor rod embedded completely through the wall with a plate washer as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete. Partially embedded adhesive anchors are not acceptable.
   8. Anchorage into Concrete: Cast-in-place high-strength headed anchor bolts or concrete anchor as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete.
   9. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09960 - High Performance Coatings.
   10. Manufacturers: One of the following or equal:
      a. Mitchell Metals, LLC. Smyrna, GA.
      b. Mapes Canopies, LLC. Lincoln, NE.
      c. Vestis Manufacturing. Spokane, WA.

M. Miscellaneous aluminum:
   1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
   2. Do not weld or flame cut.

N. Miscellaneous cast iron:
    1. General:
        a. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
        b. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
        c. Before leaving the foundry, clean castings and apply 16-mil dry film thickness coating of coal-tar epoxy, unless otherwise specified or indicated on the Drawings.

O. Miscellaneous stainless steel:
    1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.
    2. Cleaning and passivation:
        a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
        b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
        c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
            1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
        d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
            1) Passivation by citric acid treatment is not allowed.
                a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
            2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
            3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A380.
        e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A380.
        f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

P. Miscellaneous structural steel:
    1. Provide miscellaneous steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.

Q. Isolating sleeves and washers:
    1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
   2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals.
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09960 - High Performance Coatings.
      c. Aluminum in contact with concrete or masonry.

B. Aluminum stair nosing:
   1. Install stair nosings on treads of concrete stairs, including top tread on upper concrete slab.
   2. Omit stair nosings where concrete is submerged.
   3. Cast stair nosings in fresh concrete, flush with tread and riser faces. Install nosing in center of step.

C. Cast iron stop plank grooves:
   1. Recess stop plank grooves with cast iron surfaces of groove set flush with concrete surface.

D. Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.
      b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint-gap.
      c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
      d. Space attachment brackets as indicated in the manufacturer's instructions.
   2. Aluminum pipe handrails and guardrails:
      a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.

b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.
c. Discontinue handrails and guardrails at lighting fixtures.
d. Provide 1/8-inch diameter weep hole at base of each post.
e. Space posts as indicated on the Drawings.
f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
g. Space rails as indicated on the Drawings.
h. Make adequate provision for expansion and contraction of kick plates and rails.
    1) Make provisions for removable sections where indicated on the Drawings.
i. Make lower rails a single, unspliced length between posts, or continuous.
j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.
k. Draw up fasteners tight with hand wrench or screwdriver.
l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.
m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.
n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.
o. Replace damaged or disfigured handrails and guardrails with new.
p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.
    1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.
q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.

E. Ladders:
1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
2. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.
3. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
4. Erect rail straight, level, plumb, and true to position indicated on the Drawings:
    a. Correct deviations from true line or grade which are visible to the eye.

F. Manhole frames and covers:
1. Installation: As recommended by Manufacturer.

G. Metal gratings:
    1. General:
        a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.
        b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
        c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.
        d. Install angle stops at ends of grating.
        e. Installed grating shall not slide out of rebate or off support.
        f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
        g. Top surfaces of grating sections adjacent to each other shall lie in same plane.
    2. Aluminum grating:
        a. Aluminum grating: Support on aluminum shelf angles or rebates.
    3. Heavy-duty steel grating:
        a. Support on hot-dip galvanized structural steel rebates embedded and anchored in concrete.
        b. Use for roadways, traffic areas, and where indicated on the Drawings.

H. Stairs:
    1. General:
        a. Install guard railings around stair wells as indicated on the Drawings or specified.

I. Stainless Steel:
    1. Welding:
        a. Passivate field-welded surfaces:
            1) Provide cleaning, pickling and passivating as specified in this Section.
            2) Clean using Derustit Stainless Steel Cleaner, or equal.

END OF SECTION

SECTION 06608

FIBERGLASS REINFORCED PLASTIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: General fabrication and design requirements for fiberglass reinforced plastic fabrications.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D883 - Standard Terminology Relating to Plastics.
   3. D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   4. D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   6. D3299 - Standard Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks.
   7. D4097 - Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

1.03 DEFINITIONS

A. Chopped Glass: Fibrous material consisting of randomly oriented chopped filaments applied directly to a mold surface or laminated under construction by a chopper gun.

B. Equipment: The fiberglass reinforced plastic equipment, including ancillary equipment, work, and materials as described in this specification.

C. Fabrication Drawings: Those drawings produced by the Fabricator or Contractor, with the intention of providing the necessary information to construct or install the equipment.

D. Fiber Prominence (Jackstraw): The distinct visibility of individual glass strands causing a loss of translucency of the laminate.

E. Fiberglass Reinforced Plastic: Fiberglass Reinforced Plastic or glass fiber and resin fabrication consisting of approximately 35 to 55 percent glass fiber reinforcement by weight for hand lay-up structural laminates and 55 to 70 percent glass for filament wound structural laminates, unless otherwise specified.

F. Mat: Fibrous material consisting of randomly oriented chopped or swirled filaments loosely held together with a binder.

G. The terminology of this specification is in accordance with ASTM D883. Fabricators using this specification are responsible for correct interpretation.

1.04 SUBMITTALS

A. Shop drawings and calculations:
   1. Submit general arrangement and fabrication drawings, calculations, and elements of the design.
   2. Include submittal information which describes specifically how the equipment is to be built and details necessary to ascertain that products meet specified requirements. Provide in the form of drawings, standards, specifications, or other shop instructions, but may also be partially contained in quality control records. The submittal shall include, but not be limited to:
      a. Fabrication drawings.
      b. General arrangement drawings signed by an Engineer registered in the state where the project is located, showing complete structural, fasteners, and erection procedures for a complete assembly.
      c. Quality control programs.
      d. Verification that the manufacturer has been engaged in fabrication of similar fiberglass reinforced plastic equipment for a minimum of 5 years.
      e. Statement of compliance with contract design requirements, codes, and standards.
      f. Recommendation for each resin selection from resin manufacturer.
      g. Type and amounts of fillers.
      h. Nominal corrosion liner description.
      i. Reinforcement types and glass content range for hand lay-up laminates.
      j. For filament wound laminates:
         1) Helix angle.
         2) Glass content range.
         3) Strand yield.
         4) Strand per inch in the winding band.
         5) Ply thickness.
         6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.
      k. For other components:
         1) Construction type.
         2) Laminate thicknesses.
         3) Ply sequences.
         4) Glass content range.
      l. For secondary overlays (both interior and exterior):
         1) Laminate thicknesses.
         2) Ply sequences and widths.
      m. Construction details: Construction details for assembly and other special configurations, including:
         1) Tank bottom/top attachments with knuckle configuration and overlays and thicknesses.
         2) Tank support and anchor lugs, including attachment details.

3) Tank nozzles and installation, including cutout reinforcement, gusseting, and similar items.
4) Tank lateral or other support fabrication details, including platform attachment clips and/or shoulders.
5) Scrubber configuration and fabrication details of internal support system and other specialty items.
6) Cover panel joints, anchorage detail, and details of doors and inspection ports and their attachment or incorporation within the cover.

n. Miscellaneous equipment required.
o. Test reports and certification of compliance with physical property requirements.
p. Color samples.
q. Manufacturer's installation instructions.
r. ASME RTP-1 certification.

B. Operation and Maintenance Data.

C. Warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Fiberglass reinforced plastic manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce custom-made glass fiber and resin products of quality and size specified for minimum 5 years with satisfactory performance record.

B. Quality assurance plan: Fabricator shall be responsible for implementation of a comprehensive quality assurance plan. The quality assurance plan describes procedures with the following minimum requirements:
1. Fabricator shall designate personnel to inspect equipment while in process and after completion to ensure compliance to every aspect of the section and fabrication drawings.
a. Inspection shall include, as a minimum, checks for visual defects, laminate thickness and sequence, glass content, Barcol hardness, dimensional tolerances, adherence to construction details, surface preparation, and environmental conditions.
b. Fabricator's inspector shall complete a report of the findings including method of measurement for each separate assembly.
2. Prior to use of resins in fabrication, fabricator shall extract samples of resins and retain them for use by the Engineer. Sample size shall be 100 cubic centimeters minimum:
a. Take 1 sample for each manufacturer's batch number if resin is received in the form it will be used.
b. If the fabricator alters the resin after receipt, such as through the addition of styrene, promoters, or other additives, take samples from each drum or portion thereof mixed with additives.
c. Fabricator shall provide documentation for each sample including resin type, manufacturer, batch and lot number, drum number, complete listing of additives with amounts added, and description and manufacturer of each additive.

3. Fabricator shall inspect glass reinforcement prior to use in fabrication.
    a. Do not use glass that does not meet the manufacturer's acceptance standards.
    b. Do not use glass material that is wet or has been wet.
    c. For each type of glass and lot number used, fabricator shall record the manufacturer, product description, binder type, product code, production date, and lot number.
    d. For mat, woven roving, unidirectional roving, and cloth, also include in records actual measured weight per square yard of material.
4. Fabricator shall retain nozzle cutouts and other excess laminate, clearly marking each piece to identify its original location. These laminate samples become the property of the Owner.
5. For areas where valid laminate samples are not available, take sample plugs at the Engineer's request.
    a. Repair subsequent holes in a manner acceptable to the Engineer.
6. Fabricator shall verify glass content on available samples in accordance with ASTM D2584. Complete this test and submit the results complete for each major component where samples are available.
7. Prior to final shipment of the equipment, fabricator shall submit to the Engineer a complete quality control report, consisting of copies of records maintained for compliance with this Section.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design fiberglass reinforced plastic tanks, scrubbers, and other vessels following the procedures and methods, utilizing the equations and formulas, and incorporating safety factors and allowable design stresses and strains set forth in ASME RTP-1. Base the design of duct and other fiberglass reinforced plastic equipment not covered by ASME RTP-1 on the engineering rationale, applicable formulas, and safety factors set forth in ASME RTP-1.

B. Perform calculations necessary to ensure long-term, low risk service of the fiberglass reinforced plastic equipment with minimum reasonable maintenance requirements.
    1. Long-term, low risk service is defined as a service life of 20 years without major structural failure or leakage.
    2. The design shall ensure proper functioning of the equipment at the stated operating conditions.
    3. The design shall include as a minimum, engineering calculations, materials selection and documented physical and mechanical properties, and detailed drawings required for fabrication and assembly of the equipment.

C. Design in accordance with applicable national, regional, and local design and building codes.
    1. Wind and seismic forces shall be determined in accordance with the building code as specified in Section 01410 - Regulatory Requirements.

D. Resistance to overturning shall not include the weight of the liquid contained in the equipment.

E. Consider the interaction of the installed system including but not limited to thermal expansion of duct, tanks, and vessels and the effects of external loading from piping, fans, pumps, platforms, and other attached items.

F. Allow for the most severe combination of conditions which may include, but not be limited to, the following:
   1. Internal or external pressure.
   2. Static head of contents (working and test conditions).
   3. Mass of structure and contents.
   4. Design temperature including upset conditions.
   5. Superimposed loads, such as seismic and wind forces.
   6. Bending moments due to eccentric loads.
   7. Localized loads acting at supports, lugs, and other attachments.
   8. Shock loads.
   9. Loads due to heating or cooling and thermal gradients.
   10. Loads applied during transport or erection.
   11. Loads imposed by personnel during erection and operations.
   12. Fatigue.

G. Use safety factors and allowable strains specified in ASME RTP-1 unless otherwise specified. Do not use safety factors and allowable strains less than the following:
   1. Allowable hoop and axial strain shall be 0.001 inch per inch for filament wound tanks.
   2. A safety factor of 10 for hand lay-up components in tension, flexure, or other loading conditions where elastic stability is not in question.
   3. A safety factor of 5 for external loading (vacuum) or local buckling due to seismic or wind loading.

H. Safety factors for upset conditions or infrequent loading situations may be less than the above values for the specific condition if acceptable to the Engineer.

I. There will typically be other aspects which should be considered. Identify and consider their effects, identify design limitations, and submit this information.

J. Provide test reports or other documentation for laminate properties used in the design. Laminates shall be similar in construction, layer sequence, resin type, and cure to those used to determine tested properties. Properties shall be adjusted to reflect reductions at operating temperatures. Test reports shall be provided for:
   1. Grating: Indicate grating strength and deflection.
   2. Physical properties of test cover panels.
   3. Tanks showing conformance with specified strength requirements.

K. The corrosion liner shall be a minimum of 100 mils in thickness, unless otherwise specified, and documentation shall be provided verifying veil type, liner thickness, and resin cure.
   1. Consider 50 mils of the corrosion liner as sacrificial and do not include it in determining structural wall thickness.

2. Use structural wall thickness not less than 0.375 inches for tanks and vessels and 0.1875 inches for ductwork.
3. Submit minimum structural thicknesses of other types of fiberglass reinforced plastic fabrications.

L. Laminate types may include hand layup, helical winding, and hoop/chop construction methods.
1. In laminates with helix angles greater than 80 degrees and in hoop/chop laminates, orientate approximately 10 percent of the structural wall thickness at 0 degrees (longitudinal direction).
2. Apply this reinforcement in at least 2 layers of weft unidirectional fabric and equally spaced within the structural wall.

M. For tanks and scrubbers; nozzles, determine manways and shell reinforcements according to the tables and formulas in ASME RTP-1.

N. Anchor tanks and vessels using lugs and a continuous filament wound band or an integral filament wound load ledge with external stainless steel anchor clips.
1. The anchor clips shall be bolted to the concrete foundation; use non-shrink grout to level anchor clips.
2. The design shall resolve the sum of the moments and the sum of the force equal to 0.

O. Design internal beams and support attachments using a maximum of 200 pounds per square inch shear stress for secondary bonds. Also apply this to design of external lugs required for ladders, platforms, and other attached items.

2.02 RESIN AND REINFORCEMENT MATERIALS

A. General physical properties: In accordance with ASTM C582, ASTM D3299, ASTM D4097, and ASME RTP-1 with verification of properties. Physical properties may include tensile, flexural, and compression modulus of elasticity and ultimate strengths, limiting strains, Poisson ratios, coefficients of expansion, and other directional properties as required for the design of the equipment.

B. Resin:
1. Fabricate equipment using the corrosion-resistant resin(s) specified in the fiberglass reinforced plastic equipment specifications. The fabricator is required to obtain independent endorsement of each resin selection from the resin manufacturer. Unless otherwise specified, use the resin throughout laminates.
2. The type of catalyst recommended varies between resin manufacturers. Submit resin/catalyst before fabrication begins to verify compliance to the resin manufacturer's recommended procedures.
3. Employ no fillers, additives, or pigments in the resin.
a. A thixotropic agent for viscosity control may be used in the proportion and type recommended by the resin manufacturer.
b. Use no thixotropic agent in the corrosion liner or on surfaces to be in contact with the corrosive environment.

4. Make resin putty using the same resin as was used in the original fabrication and shall contain milled glass fibers.
    a. The use of silica flour, grinding dust, or other fillers is not allowed.
5. When specified, add antimony trioxide or antimony pentoxide to the resin in the amount necessary to achieve the required fire retardancy rating in the structural wall only. Follow resin manufacturer's recommendations.
    a. Unless otherwise specified, the corrosion liner shall not contain this additive.

C. Reinforcement:
1. Show the type and sequence of reinforcements to be used on the fabrication drawings.
2. Use as commercial grade corrosion-resistant borosilicate glass fiber reinforcement, unless otherwise specified.
3. Use glass fiber reinforcing having a surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used.
4. Use Type C (chemical grade) glass, 10 mils (0.01 inches) thickness, or polyester surfacing veil, such as Nexus surfacing veils.
5. Use Type E (electrical grade) glass, 1-1/2 ounces or 3/4-ounce per square foot, with nominal fiber length of 1.25, within 0.75 inches mat.
6. Continuous glass roving used in chopper guns for spray up shall be Type E chopper roving.
7. Woven roving shall be 24 ounces per square yard Type E glass and have a 5-by-4 plain weave.
8. Continuous roving used in filament wound structures shall be Type E glass winder roving with a yield of 200 yards or more per pound.
9. Use Type E glass unidirectional fabric. Weft unidirectional fabric shall be 15.7 ounces per square yard.
10. When specified, use Type ECR glass reinforcements supplied in similar fabric styles to those specified above.

2.03 FABRICATION

A. Molds:
1. Construct molds of a suitable material to produce a smooth and glossy corrosion liner surface on the fiberglass reinforced plastic equipment.
2. Covering of mandrels with cardboard must be accepted by the Engineer prior to start of fabrication.

B. Laminates:
1. Determine specified glass content in accordance with ASTM D2584.
2. Consider laminate thicknesses shown on the fabrication drawings as construction minimums. Verify that minimum thicknesses are obtained using the laminate sequences specified. When only total laminate thicknesses are specified or indicated on the Drawings, the minimum allowable structural laminate thickness shall be the total laminate thickness less the specified corrosion liner thickness.
3. Interruptions in laminating sequence shall follow the application of a ply of mat and be succeeded by a ply of mat.

4. The interruption shall not exceed 24 hours, and the in-process surface must retain acetone sensitivity until laminating is resumed. Lack of compliance with these aspects or indication that contamination of the surface has occurred shall require that surface preparation be accomplished before resuming.
5. Chopped strand glass applied by chopper gun is allowed in lieu of mat layers in the structural laminates only.
    a. Chopper gun application of the corrosion liner is not allowed.
6. Coat non-mold surfaces with resin containing wax additive in the amount necessary to allow full cure of the surface. In the case of exterior surfaces, this wax coat shall also contain an ultraviolet stabilizer in the type and amount recommended by the resin manufacturer.
7. The exterior surface of equipment shall be resin-rich and reinforced with 1 layer C glass surfacing veil, unless otherwise specified.
8. When specified, the exterior coat shall be an opaque pigmented surface coat, applied only after Engineer's inspection. Color shall be selected by the Engineer.

C. Corrosion liner laminates:
1. The inner surface of laminates shall be resin-rich and reinforced with surfacing veil of the type and number of layers as shown on the fabrication drawings.
2. The interior layer of the corrosion liner shall consist of 1-1/2 ounces per square foot mat in the number of layers specified on the fabrication drawings. An exotherm interruption is specifically prohibited within the corrosion liner.
3. Chopped glass applied by chopper gun is not allowed in the corrosion liner.
4. Plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
5. Completed corrosion liner as described above shall contain not less than 20 percent nor more than 30 percent glass by weight.
    a. Use no thixotropic material in the resin for the liner, nor in the fabrication of fiberglass reinforced plastic components intended for internal service.
    b. The completed liner shall be the minimum thickness specified or indicated on the Drawings.
6. Do not use a separately cured unreinforced gel coat.

D. Hand lay-up structural laminates:
1. The corrosion liner laminate shall be followed by hand lay-up structural laminates of varying reinforcement sequences as indicated on the fabrication drawings.
2. For hand lay-up structural laminates, reinforcement shall consist of mat and woven roving in the sequence specified on the fabrication drawings.
3. Woven roving shall have a ply of mat on each side. Two adjacent plies of woven roving are not permitted.
4. Laminates containing primarily 1-1/2 ounces per square foot mat layers in conjunction with woven roving shall contain not less than 35 percent or more than 45 percent glass (by weight).
5. Laminates containing primarily 3/4-ounce per square foot mat layers in conjunction with woven roving are considered to be high strength laminates and shall contain not less than 45 percent or more than 55 percent glass by weight.

E. Filament wound structural laminates:
   1. The corrosion liner laminate shall be followed by filament wound structural laminates as indicated on the fabrication drawings.
   2. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained.
      a. This laminate shall contain 55 to 70 percent glass by weight as indicated on the fabrication drawings.
   3. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely covers the surface with 2 bi-directional layers.
      a. Each layer shall be a maximum of 1 roving in thickness.
      b. Uniformly space the filaments across the winding band without bunching or gaping.
   4. Specify the helix angle of winding on the approved fabrication drawings, as measured from the centerline of revolution of the equipment shell.
   5. Tolerance on helix angle is plus or minus 2 degrees, unless otherwise specified.
   6. The fabrication drawings may require that layers of unidirectional roving be interspersed within the continuous filament winding.
   7. Apply the unidirectional roving with the glass strand aligned in the axial direction, to within plus or minus 5 degrees.
   8. If layers of mat or chopped glass are needed to ensure proper bonding of unidirectional roving, or within the filament winding to accommodate the Fabricator's manufacturing methods, consider the layers' extra material that will result in a thickness greater than specified. The amount of filament winding and unidirectional roving specified must still be applied.

F. Joining laminates:
   1. Fiberglass reinforced plastic joining laminates are subject to applicable requirements specified in other sections for laminates.
   2. Reinforce fiberglass reinforced plastic joints with an overlay of glass reinforcement and resin which extends equally within plus or minus 1/2 inch on each side of the joint. Use minimum thickness, ply sequence, and ply widths of fiberglass reinforced plastic joints as indicated on fabrication drawings.
   3. Restrain parts to be joined to prevent movement until completion and cure of the joint overlay.
   4. Fit-up parts and verify that tolerances and assembly requirements are satisfied. Completely fill the void between component parts with resin putty, taking care not to extrude an excessive amount of putty into the interior.

G. Environment:
   1. The fabrication process and materials at the point of fabrication are to be maintained within a range of 60 to 95 degrees Fahrenheit. This temperature must also be at least 5 degrees greater than wet bulb temperature, as measured with a sling psychrometer.
   2. Store materials in a dry area and within the temperature and humidity limits recommended by the manufacturers.

H. Flanges:
   1. Make flanges by hand lay-up construction with nozzle neck and flange made integrally in 1 piece and fabricated in accordance with the dimensions

indicated on the fabrication drawings. Extend layers of reinforcement in the nozzle neck and hub uninterrupted into the flange.

2. Build-up additional hub thickness using alternating layers of 1-1/2 ounces per square foot mat and 24 ounces per square yard woven roving.
3. Build-up additional thickness in the flange using "ring" cutouts of mat, evenly distributed throughout the flange thickness.
4. Press molded or filament wound flanges are not allowed.
5. Overall machine facing of the back of flanges is not permitted.
   a. To obtain proper seating, spotface bolt holes for SAE size washers.
   b. Resin coat bolt holes and other cut surfaces so that no fibers are exposed.
   c. Spotfacing shall not produce a flange thickness less than indicated in the fabrication drawings.
6. Bolt holes in flanges shall straddle principal centerlines of the Equipment. Tolerance in bolt hole locations and in diameter of bolt circle shall be plus 1/16 inch.
7. Depressions or projections in flange face shall be no greater than 1/32 inch.

I. Allowable visual defects:
   1. Visual defects in areas of the equipment shall not exceed the maximum allowable levels of visual defects set forth in Table A, unless acceptable to Engineer.
   2. Visual defects in accordance with ASTM D2563.
   3. Presence of visual defects in excess of the allowable levels of Table A shall be grounds for rejection of the equipment. Listed quantities apply to small, localized areas and shall not be averaged over larger areas.
   4. For the purpose of Table A, use of the following definitions apply:
      a. INNER surface - Interior process surface, thickness of surfacing veil(s), and interface between veils and mat layers. Includes surfacing veils on internal joints.
      b. Interior mat layers - Layers of mat following the inner surface, and interface between liner and structural wall. Includes mat layers on internal joints.
      c. Structural wall - Layers of filament winding or alternating layers of mat and woven roving following the corrosion liner, and layers of mat and woven roving in internal overlays.
      d. Exterior surface - The exterior surface of the laminate and the thickness of the surfacing veil.
      e. Dimensions listed in Table A refer to the largest dimension measured for defects.

TABLE A
MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS

Condition/ Defect	Inner Surface	Interior Mat Layers	Structural Wall	Exterior Surface
Chip	None	None	None	
Crack	None	None	None	
Crazing	None	None	None	

TABLE A MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS				
Condition/ Defect	**Inner Surface**	**Interior Mat Layers**	**Structural Wall**	**Exterior Surface**
Delamination	None	None	See Air Bubble	
Dry Spot	None	See Air Bubble	See Air Bubble	
Foreign Inclusion	None	Maximum Diameter 1/32"	See Air Bubble	
Fracture	None	None	None	None
Air Bubble/ Void	Less than 1/64" Ø unlimited. 1/64" to 1/16" Ø 2 / sq. in. Maximum Diameter 1/16"	Less than 1/32" Ø unlimited. 1/32" to 1/8" Ø 5 / sq. in. Maximum Diameter 1/8"	Less than 3/16" Ø unlimited. 3/16" to 1/4" Ø 2 / sq. in. Maximum Diameter 1/4"	
Blister	See Air Bubble	See Air Bubble	See Air Bubble	
Burned	None	None	None	
Pit (Pinhole)	Less than 1/32" Ø 50/square feet 1/32" to 1/16" Ø 10/square feet Maximum Diameter 1/16" Maximum Depth 1/32"	N/A	N/A	
Resin Pocket	None	Maximum 1 square inch per occurrence.	Maximum 1 square inch per occurrence.	
Wrinkle	Allowable if laminate is glass reinforced. No sharp edges allowed.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	
Scratch	None	N/A	N/A	
Fiber Prominence	None	Maximum 10 fibers visible per square inch	Maximum 20 fibers visible per square inch	

2.04 SOURCE QUALITY CONTROL

A. Inspection:
   1. Owner's inspection: Permit the Engineer access to the equipment during fabrication and upon completion for the purpose of verifying compliance to the

Contract Documents. The inspection is not intended to replace the Fabricator's own quality control procedures.

2. In no respect does inspection of equipment by Engineer relieve the Fabricator of compliance with the Contract Documents.
   a. A final inspection will be performed by the Engineer.
3. The Fabricator shall notify the Engineer at the completion of particular milestones during fabrication. The milestones are as follows:
   a. View tooling prior to fabrication.
   b. Beginning application of corrosion liner for each part, extraction of each part prior to beginning assembly.
   c. Upon completion of each separate assembly, Engineer reserves the right to include additional milestones.
4. Allow Engineer to photograph the equipment while in process and/or upon completion.
5. Engineer may use magnification or other special viewing or measurement devices during inspection.
6. Evidence of poor workmanship or lack of compliance with aspects of the Contract Documents will be grounds for rejection of the equipment.
7. Subsequent repair of rejected equipment may, at the Engineer's option, be undertaken in an attempt to bring the equipment to an acceptable state.
   a. Repair procedures must be accepted by the Engineer prior to implementation.

2.05 TESTING

A. The Engineer may employ destructive testing, such as ultimate tensile or flexure strength tests or glass content ignition tests, on available samples or use other non-destructive test methods, such as acoustic emission or ultrasonic polygauge thickness measurement, on the completed equipment for verification of compliance to the contract documents.

B. Testing performed by the Engineer will be accomplished through use of applicable ASTM test methods when appropriate.

C. Hardness tests will be made for acceptance by the Engineer on the liner surface using the Barcol impressor, Model GYZJ 934 1, calibrated at 2 points in accordance with ASTM D2583.
   1. Ten readings will be taken in a localized area, deleting the 2 highest and 2 lowest, and averaging the remaining 6.
   2. Minimum acceptable Barcol hardness will be a reading of 30 unless otherwise specified.

D. An acetone sensitivity test will also be performed by the Engineer as an acceptance criteria. Evidence of a sticky or tacky surface following rubbing with an acetone-saturated cloth will be grounds for rejection of the equipment.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 06611

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fiberglass reinforced plastic fabrications including:
      a. Grating and stair treads.
      b. Troughs.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. F 101 - Contact-Molded, Fiberglass-Reinforced Plastic Wash-Water Troughs and Launders.
   2. F 102 - Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets.

B. ASTM International (ASTM):
   1. D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   2. D638 - Standard Test Method for Tensile Properties of Plastics.
   3. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   4. D2583 - Standard Test Method for Indentation of Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components-Health Effects.

D. United States Department of Agriculture (USDA).

E. United States Department of the Interior:
   1. Bureau of Reclamation (USBR):
      a. ISO 9826 - Water Measurement Manual, Measurement of Liquid Flow in Open Channel.

1.03 SUBMITTALS

A. Submit general arrangement and fabrication drawings, calculations, and elements of the design for grating and stairs.

B. Product Data.

C. Manufacturer's Installation Instructions.

D. A copy of this specification section, with each paragraph checked marked to show specification compliance or marked to show deviations.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Parshall flume liner: Provide temporary bracing for liner to ensure maintenance of dimensions during shipment. Maintain bracing in place for installation.

PART 2 PRODUCTS

2.01 GRATING AND STAIR TREADS

A. Manufacturers: One of the following or equal:
   1. Fibergrate Composite Structures, Safe-T-Span.
   2. Strongwell, Duradek.

B. Materials:
   1. Core: Unidirectionally aligned glass fibers.
   2. Mat: Submit standard corrosion liner.
   3. Veil: Submit standard corrosion liner.
   4. Ultraviolet stabilizer: Added to the exterior surfaces in the type and amount recommended by the resin manufacturer.
   5. Resin: Fire retardant premium vinyl ester, antimony trioxide or pentoxide added to meet Class I flame spread rating of ASTM E84 and self-extinguishing requirements of ASTM D635.
   6. Manufacturers: One of the following or equal:
      a. Dow Derakane 530.
      b. Ashland Hetron 992.
      c. Interplastic VE 8400.
      d. Reichhold Dion VER 9300FR.
   7. Color: Grey or as indicated on the Drawings.
   8. Anti-slip coating: Permanently bonded grit of selected color.

C. Design criteria and chemical exposure:
   1. Deflection and concentrated load: Maximum 0.15 inch at span of 48 inches under concentrated load of 250 pounds.
   2. Deflection and uniform distributed load: Capable of carrying uniform distributed load of 100 pounds per square foot on simple span of 64inches without deflecting more than 0.25 inches.
   3. Weight: Maximum 3.1 pounds per square foot for 1-1/2-inch high grating with open area of minimum 50 percent.
   4. Suitability: Use stairs and grating suitable for use in environments containing chlorine and sulfuric acid solutions at the temperatures and concentrations specified for the application.

D. Components:
   1. Bearing bars: I-bars, 1-1/2-inch high depth as indicated on the Drawings, I-bars spaced at 1-3/16 inch on center.
   2. Cross bars: 3/8-inch diameter spaced at 6 inches on center.

3. Hold downs, connectors, and accessories: As recommended by grating manufacturer.

E. Fabrication:
   1. Produce grating bearing and cross bars by pultrusion process. Do not use hand lay-up construction methods.
   2. Coat ends of grating with resin.
   3. Fabricate single sections for each span. Do not clamp 2 or more grating sections together within spans.
   4. Type 316 stainless steel plates and angles at openings:
      a. Install 5/8-inch thick plate or angle where required to fill openings at changes in elevation and at openings between equipment and grating.
      b. Install angle stops at ends of grating to prevent grating from sliding.
   5. Maximum 1/8-inch clearance allowed between ends of grating and inside face of vertical leg of support angles.

F. Cutouts:
   1. Provide where required for equipment access or penetrations, including valve operators, stems, and gate frames.
   2. Seal cut edges with resin.

2.02 TROUGHS

A. General:
   1. Products shall hold current NSF 61 certification for use in contact with potable water.

B. Manufacturers: One of the following or equal:
   1. Warminster Fiberglass Co.
   2. Orthos Liquid Systems, Inc.
   3. Protectolite Composites Inc.

C. Materials:
   1. Fabricate trough of premium grade fiberglass reinforced polyester resin, with fiberglass constituting a minimum 20 percent by weight.
   2. Glass reinforcement shall be random chopped-strand type with a minimum strand length of 1 inch, and adequate contact molding pressure to provide complete wet-out of the glass fibers, and shall be in accordance with AWWA F101.
   3. Resin shall contain no filters or additives except as follows.
      a. Fillers up to 2 percent by weight of a thixotropic agent may be used for viscosity control in the paraffinated top coat provided it does not interfere with the visual inspection or chemical resistance of the laminate.
      b. Resin may contain pigments, dyes, or colorants which have been determined by at least 5 years previous service to be acceptable for the service condition without fading or chalking from original color standard
      c. The cure system used for the resins shall be in accordance with the resin manufacturer's current recommendations.
         1) A separately cured, unreinforced gel coat shall not be used.
            a) No surface shall be acetone sensitive.

4. Minimum physical properties:
    a. Tensile strength: 14,000 pounds per square inch.
    b. Flexural strength: 25,000 pounds per square inch.
    c. Flexural modulus: 1.0 times 10^6 pounds per square inch.
    d. Trough resin and all accessories shall be suitable for the specific operating environment.
5. All trough supports and hardware shall be Type 316 stainless steel including bolts, nuts washers, straps, etc.
    a. Stainless steel structural supports shall be manufactured as specified in Section 05500 - Metal Fabrications.
6. All materials used in the construction of the troughs and accessories shall be approved for use in potable water.

D. Design:
1. Construction and design in accordance with AWWA F101 and this specification.
2. Troughs shall be designed for collection of backwash water at the maximum rate of approximately 1,900 gpm per trough. The minimum size of the trough shall be 18-inches wide by 22-inches deep, Supplier to confirm trough sizing. Sixteen troughs shall be provided for each of the sixteen filters.
3. Troughs shall be certified for use in potable water in accordance with NSF Standard 61.
4. Trough shall be laminated of fiberglass reinforced polyester resin to a minimum thickness of 1/4 inch.
5. Inside surface of each trough shall have a smooth gel coat finish, color as selected by the Engineer. The outside surface of each trough shall be resin sealed with no exposed glass fiber.
6. Color shall be molded in and an ultraviolet inhibitor shall be used.
7. Troughs shall have round bottoms and vertical sides, unless otherwise indicated on the Drawings.
8. Longitudinal stiffening ribs shall be integrally molded on the outside of the troughs to ensure rigidity. Troughs shall be designed to meet specified requirements without the need of external bracing.
    a. Longitudinal stiffening ribs shall be constructed of metal reinforcing materials completely encapsulated with a minimum of 1/8-inch thick laminate extending a minimum of 2 inches beyond the reinforcing material.
9. Spacer rods:
    a. Sufficient plastic spacer rods shall be included to maintain a uniform width over the length of each trough.
    b. Spacer rods shall be spaced to prevent buckling and to provide maximum resistance to water loading on the sidewall of the trough.
10. Support system shall allow 1-inch minimum adjustment of the trough, horizontally and vertically, and shall allow no greater than the unsupported span divided by 1,000 (L/1,000) upward deflection while the trough is empty and water outside the trough is to the weir edge. Maximum vertical deflection shall not exceed the unsupported span divided by 1,000 (L/1,000) downward while the trough is full and water outside the trough is below the trough bottom.
11. Thickness of laminate at all supports such as saddles shall be a least 150 percent of the nominal thickness of the trough.

12. End flanges and blind ends shall be minimum of 1.5 times the nominal thickness of the trough, conforming to the fiber stress limitations as specified, and designed for anchorage loadings.
13. An integrally molded water stop shall be provided on the discharge end of the trough. Water stop shall be located at the center of the gullet wall. The back end of the trough shall be integrally closed with FRP and shall have 316 stainless steel support brackets and hardware for bolting against the filter wall.
14. Troughs shall have fixed weir walls (i.e., no adjustable weir plates).
15. Top edges of trough shall be level, straight, and parallel with a tolerance of 1/16-inch deviation from true plane measured when the trough is unloaded.
16. Design troughs, supports and anchors to span between supports, within stress and deflection limitation, under the following loads:
    a. Gravity load: Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as spreader bars, together with the weight of the water to fill the trough. Any additional loads, such as piping shall also be considered.
    b. Buoyant load: The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.
    c. Lateral load: Loads acting against the trough side walls, specifically those induced by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or when the trough is full and the tank is empty, shall be used when calculating deflection, fiber stress, etc. Include sloshing load due to seismic forces on both the trough and the support system.
    d. Thermal stresses: The troughs shall be designed to accommodate temperature induced stresses resulting from different coefficients of thermal expansion and contraction between the trough and tank/support materials.
    e. Torsional stability: The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges without the need for external trough-to-trough bracing. Any or all of the following trough stabilization techniques shall be considered:
        1) Torsional stiffeners within trough.
        2) Spacer rods within trough.
        3) Internal baffles and/or flow straighteners.
    f. Loads specified in Section 01850 - Design Criteria, and applicable for the locations of the troughs in the Work:
        1) Seismic load.
        2) Wind load.
17. Deflection under load:
    a. Maximum vertical deflection under full buoyant load or gravity load shall be less than or equal to L/1,000, where L is defined as the unsupported trough length inches. Under no circumstance shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16 inch.
    b. Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to D/100, where D is defined as the trough depth in inches. Under no circumstances shall the maximum side wall deflection exceed 3/16 inch.

c. Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to W/100, where W is defined as the trough width in inches. Under no circumstances shall the maximum bottom deflection exceed 3/16 inch.

18. Fiber stress limitations:
    a. Supplemental to the deflection criteria, the troughs shall also be designed such that the maximum wall stress under the most severe loading conditions is less than or equal to 1,500 pounds per square inch in accordance with AWWA F101.
    b. Stress shall be calculated for the fiberglass only and shall not include any additional embedded reinforcing materials.
    c. This stress criterion is equivalent to 7:1 safety factor (approximate) as applied to the tensile and flexural properties of contact molded troughs and launders.
19. Thermal expansion and contraction: The troughs shall be designed and detailed to accommodate a thermally induced expansion and contraction of 1/8 inch per 20-foot length of trough over temperature range of 10 degrees Fahrenheit to 100 degrees Fahrenheit, without exceeding the deflection or strain limitations set forth in the referenced standards and in the proceeding paragraphs.
20. Provide calculations sealed and signed by a registered professional structural engineer registered in the state Utah for seismic sloshing loads and design of trough support system. All other calculations shall be sealed and signed by a registered professional engineer.
21. Trough manufacturer shall be responsible to design the troughs and all supporting members and accessories required for a complete installation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified in Section 01600 - Product Requirements.

3.02 ERECTION AND INSTALLATION, GENERAL

A. Install products where indicated on the Drawings in accordance with manufacturer's printed instructions.

3.03 TROUGHS

A. Install products in accordance with manufacturer’s instructions.

B. Protect filter media, underdrain system, appurtenances, and existing concrete from damage during trough installation.

C. All holes and other cut surfaces shall be sanded smooth and resin sealed.

D. Ensure that products are installed plumb and true, free of warp or twist, within tolerances specified by the manufacturer, as indicated in the Contract Documents.

E. Fasten to concrete with Type 316 stainless steel anchor bolts or concrete anchors.

F. Seal edges between concrete and trough with synthetic rubber.

G. Use Type 316 stainless steel nuts, bolts, and washers.

H. Set in place with weir edges to elevations indicated. Troughs shall be aligned and leveled to within 1/32-inch maximum variation between any 2 points on the weir edges.
   1. Across individual filter basins, align trough weirs within plus or minus 1/16 inch of each other.

END OF SECTION

SECTION 07110

DAMPPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Dampproofing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Conform to volatile organic compound limits.

B. Do not apply bituminous dampproofing when temperatures are 40 degrees Fahrenheit or lower or when rain is forecast for the 24 hours following application.

PART 2 PRODUCTS

2.01 MATERIALS

A. Dampproofing: ASTM D1227, Asbestos Free, Emulsified Asphalt Coatings:
   1. Manufacturers: One of the following or equal:
      a. Karnak Corp., Karnak 220 AF.
      b. W.R. Meadows, Inc., Sealmastic Type 2 Asphalt Emulsion Dampproofing.

B. Sealing mastic: Type compatible with dampproofing and free of toxic solvents with thick mastic consistency and smooth and uniform in composition product as recommended by dampproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for application of products in accordance with manufacturer's recommendations.

B. Verify that surfaces to receive dampproofing are clean, dry, reasonably smooth, free of dust, dirt, voids, cracks, or sharp projections.

3.02 APPLICATION

A. Completely cover surfaces to receive dampproofing with 2 coats:
   1. Applied by brush or spray.
   2. Apply dampproofing at manufacturer's recommended rate of application or minimum 2 gallons per 100 square feet, whichever is greater.

B. Extend dampproofing to 6 inches above finish grade.

C. Apply each coat evenly so surfaces have uniform black appearance.

D. Apply second coat at right angles to first, allowing not less than 24 hours between coats.

E. Seal around items and services projecting through dampproofing surfaces in accordance with manufacturer's recommendations.

F. Ensure sealed areas are moisture tight.

G. Backfill completely against dampproofing application within time recommended by manufacturer.

END OF SECTION

SECTION 07130

SHEET WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Self-adhering preformed rubberized asphalt and polyethylene elastomeric sheet waterproofing with protection board.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D146 - Standard Test Method for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.
   2. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomeric-Tension.
   3. E96 - Standard Test Method for Water Vapor Transmission of Materials.
   4. E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.

B. U.S. General Services Administration (GSA):
   1. PBS 07111.

1.03 SUBMITTALS

A. Submit the following:
   1. Shop Drawings.
   2. Product Data.
   3. Samples.
   4. Manufacturer's Installation Instructions.
   5. Manufacturer's Field Reports.
   6. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer-approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

C. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Comply with volatile organic compound (VOC) regulations in effect where Project is located.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's written instructions.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Do not apply waterproofing membrane during inclement weather or when air temperature is below 40 degrees Fahrenheit.
   2. Do not apply waterproofing membrane to damp, dirty, or dusty surfaces.
   3. Provide positive ventilation when waterproofing membrane is applied in enclosed areas.

1.08 WARRANTY

A. Warrant to correct failures of waterproofing to resist penetration of water, including hairline cracking due to temperature or shrinkage, for 5 years, except where failures result from structural failures of building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sheet membrane waterproofing:
   1. One of the following or equal:
      a. W. R. Grace Co.
      b. W. R. Meadows, Inc.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements: System shall be inert to petroleum distillates, oils and greases, salts, acids, alkalis, and other contaminants system shall not mildew, rot, or deteriorate due to oxidation.

2.03 MATERIALS

A. Sheet membrane: Bituthene 4000 Waterproofing Membrane, minimum 60 mils thick, self-adhering preformed membrane, composed of 54-mil thick rubberized asphalt covered with strippable release paper in 36-inch wide by 60 feet long rolls, with following properties:
   1. Pliability: Unaffected when tested in accordance with ASTM D146, 180 degree bend over 1-inch mandrel at 25 degrees Fahrenheit.
   2. Puncture resistance (membrane): Minimum 40 pounds when tested in accordance with ASTM E154.

3. Puncture resistance (film): Minimum 250 ounces when tested.
4. Resistance to hydrostatic head: No failure at 150 feet head when tested by manufacturer's procedure.
5. Microorganism resistance (16 week soil burial): No effect when tested in accordance with GSA - PBS 07111.
6. Tensile strength (film): Minimum 4,000 pounds per square inch when tested in accordance with ASTM D412.
7. Tensile strength (membrane): Minimum 250 pounds per square inch when tested in accordance with ASTM D412.
8. Elongation: Minimum 300 percent when tested in accordance with ASTM D412.
9. Permeance: Maximum 0.1 permeance when tested in accordance with ASTM E96, Procedure B.

B. Liquid membrane: Bituthene liquid membrane for fillets and reinforcement.

C. Surface conditioner: Bituthene System 4000.

D. Primer: Bituthene low volatile organic compound content primer.

E. Mastic: Bituthene mastic used to seal terminations.

F. Joint and crack sealant: In accordance with waterproofing membrane manufacturer's instructions.

G. Back-up material: Butyl rod, closed cell polyethylene or other suitable support material.

H. Protection board: Expanded polystyrene, 1-inch thick, 1.0 pound per cubic foot density with an R-valve of 4.

I. Protection board adhesive: Bituthene protection board adhesive, adheres protection board to membrane.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete cure time meets manufacturer's instructions.

B. Ensure that drains, sleeves, and curbs which pass through surfaces to receive waterproofing are properly and rigidly installed.

C. Ensure that concrete slab surfaces to receive waterproofing membrane have been lightly troweled and finished with fine hair broom.

D. Ensure that surfaces are free of cracks, depressions, waves, or projections which may be detrimental to proper installation of waterproofing membrane. Repair surfaces as required.

E. Ensure that expansion joints are sharply formed, free of broken edges or loose aggregates.

3.02 PREPARATION

A. Clean surfaces of dust, dirt, grease, oil, and other foreign matter detrimental to proper installation of waterproofing membrane.

B. Brush blast surfaces to receive waterproofing to remove laitance and loose concrete and to expose a uniform sound profile similar to medium grade sandpaper.

C. Prime polyvinyl chloride piping in contact with surfaces to be waterproofed with primer and apply and sheet waterproofing.

D. Pretreat shrinkage and non-moving structural cracks under 1/16-inch wide with waterproofing extending at least 3 inches either side of cracks.

E. Rout out moving structural joints, cold joints, and cracks 1/16-inch wide or wider to 1/4-inch wide by 1/2-inch deep, insert joint backing, seal with sealant, and pretreat cracks and joints with waterproofing extending at least 3 inches either side of cracks and joints.

F. Fill bug holes over 1/2-inch long and 1/4-inch deep with dry pack and finish flush with surrounding surfaces.

G. Fill form tie rod holes flush with surrounding surfaces.

H. Grind fins smooth.

I. Feather irregular construction joints with repair material or grind irregular construction joints smooth.

J. Apply non-decaying material at interior corners to form 1-inch cants.

3.03 CONDITIONING/PRIMING

A. Apply conditioner/primer to area to be covered by waterproofing during same day.

B. Apply by spray, roller or brush at 250 or 350 square feet per gallon in accordance with manufacturer's instructions.

C. Allow to dry 1 hour or until tack free.

3.04 APPLICATION ON VERTICAL SURFACES

A. Apply waterproofing membrane in accordance with manufacturer's recommendations.

B. Apply sheet waterproofing vertically in sections of 8 feet long or less. On walls higher than 8 feet, overlap lower section at least 2-1/2 inches with upper section.

C. Press sheet waterproofing in place with heavy hand pressure or rollers during application.

D. Apply sheet waterproofing over edge of slab or over top of foundation or parapet wall where indicated on the Drawings.

E. When sheet waterproofing is terminated on vertical surfaces, press sheet waterproofing very firmly against surface with smooth metal or hardwood tools.

F. Overlap seams at least 2-1/2 inches. Stagger end laps.

G. Patch misaligned or inadequately lapped seams with sheet waterproofing.

H. Slit fishmouths, overlap flaps, and patch with sheet waterproofing.

I. Apply troweled beads of mastic along terminations, patch edges, and laps within 12 inches of corner.

J. Apply minimum 11-inch wide strip of sheet waterproofing to corners with strip centered on corners.

K. Apply protection board over sheet waterproofing areas to be backfilled.

3.05 APPLICATION ON HORIZONTAL SURFACES

A. Apply waterproofing membrane in accordance with manufacturer's recommendations.

B. Start application at low point. Overlap sheets by at least 2-1/2 inches.

C. Apply 2 plies of sheet membrane on below grade, earth sheltered, or wood surfaces.

D. Firmly roll sheet membrane as soon as possible to minimize bubbles.
   1. Use linoleum roller of standard water filled garden roller less than 30 inches wide and weighing approximately 75 pounds when filled.
   2. Cover face of roller with resilient materials such as 1/2-inch plastic foam or 2 wraps of indoor-outdoor carpet.

E. Apply double layer of sheet membrane around posts or projections at least 6 inches in all directions and seal terminations with mastic over double layer of sheet membrane under clamping rings.
   1. Apply mastic at terminations and at tee joints at end of each working day.

F. Terminate sheet membrane on vertical surfaces by pressing membrane very firmly against surface with smooth metal or hardwood tools.

G. Overlap seams at least 2-1/2 inches. Stagger end laps.

H. Patch misaligned or inadequately lapped seams with sheet waterproofing.

I. Slit fishmouths, overlap flaps, and patch with sheet waterproofing.

J. Apply troweled beads of mastic to terminations, patch edges and laps within 12 inches of corners.

K. Ease outside corners until free of sharp edges.

L. Form inside corners with liquid membrane fillet with minimum 3/4-inch face.

M. Apply minimum 11-inch wide strip of sheet waterproofing to corners with strip centered on corners.

3.06 INSPECTION AND TESTING

A. Obtain approval of flood testing before start of testing.

B. On completion of installation of membrane, dam areas in preparation for flood testing.

C. Flood horizontal waterproofed areas with minimum 2-inch head of water for 24 hours.
   1. Mark leaks.
   2. Repair defects when membrane is dry.

D. Repeat flood-test until area is leak free.

3.07 APPLICATION OF PROTECTION COURSE

A. Apply protection course as soon as membrane is tested and allowed to dry.

B. Cut sheets to fit intersecting surfaces and protrusions.

C. Apply minimum five 1-inch diameter spots of adhesive for each 24- by 48-inch board.

D. Allow adhesive to partially dry, typically 5 to 10 minutes depending on temperature and wind. Then slide boards into place and press to provide good contact. Butt boards together with no gaps larger than 1/4 inch.

3.08 FIELD QUALITY CONTROL

A. Perform inspection of membrane waterproofing to ensure conformance with requirements. When defects are revealed, additional tests may be required to ascertain full extent of defects.

END OF SECTION

SECTION 07190

WATER REPELLENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Water repellent for concrete masonry and concrete

1.02 REFERENCES

A. International Union of Testing and Research Laboratories for Materials and Structures:
   1. RILEM Test Method No. 11.4 - Measurement of Water Absorption Under Low Pressure.

1.03 DEFINITIONS

A. Water Repellent: Resistance to penetration of water from rainfall.

1.04 SUBMITTALS

A. Product Data.

B. Samples: Water repellent applied on 8-inch by 8-inch substrates to receive water repellent, marked with application date and application rate.

C. Manufacturer's Application Instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of water repellents for minimum of 5 years with satisfactory performance record.

B. Applicator qualifications: Trained, approved, and accepted by water repellent manufacturer.

C. Spray personnel qualifications: Minimum 2 years of experience spraying exotic coatings.

D. Regulatory requirements: Comply with volatile organic compound regulations.

E. Mock-ups:
   1. Apply water repellent on 8-foot by 8-foot mock-up walls. Use same equipment and procedures that will be used in applying material on walls.
   2. Test mock-up for water penetration 30 days after applying water repellent in accordance with field quality control.
   3. When accepted by the Engineer, mock-up walls will be standard for walls.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original containers with seals unbroken and labeled with manufacturer's batch number.

B. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Apply water repellent under temperature and relative humidity conditions before, during, and after application in accordance with manufacturer's instructions.

B. Allow surfaces to dry for minimum 5 days after rains.

1.08 PROJECT CONDITIONS

A. Make proper material allowance based upon substrate material and surface configuration when determining quantities of material.

1.09 WARRANTY

A. Warrant to furnish and apply water repellent on walls that experience water penetration because of failure of water repellent for minimum 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Water repellent sealer:
   1. One of the following or equal:
      a. DIEDRICH Technologies, Inc.
      b. Rainguard Products.
      c. ProSoCo, Inc.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements: Surfaces with water repellent shall be uniform in color with unaltered texture.

2.03 MATERIALS

A. Water repellent sealer for concrete and concrete masonry: Silane/siloxane; volatile organic compound compliant; free of silicone oils, paraffin wax, or urethanes.
   1. Manufacturers: The following or equal:
      a. Rainguard, Blok-Lok™.
      b. DIEDRICH Technologies, Inc., DIEDRICH 303WB.

2.04 EQUIPMENT

A. Spray equipment: High-volume, low-pressure, airless, with maximum 60 pounds per square inch pressure:
   1. Pump: Non-atomizing, able to flow material on walls at minimum 1 to 1-1/2 gallons per minute.
   2. Orifice size for concrete, slump block, exposed concrete aggregate, and cement plaster: 0.060 to 0.110 inches.
   3. Orifice size for brick, clay brick tile, brick veneer, stone, and wood: 0.060 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Carefully inspect installed construction. Verify that construction is ready for repellent application.

B. Require manufacturer's representative to verify that water repellent may be installed.

3.02 PREPARATION

A. Allow concrete or masonry walls to cure at least 30 days before applying water repellent.

B. Clean wall surfaces of soil, mud, efflorescence, or other detrimental materials.

C. Tuck-point or caulk cracks, other than hairline cracks.

D. Route out defective mortar joints, point with mortar and tool.

E. Moisture content: Apply water repellent sealer when moisture content of substrate is 15 percent or less.

3.03 APPLICATION ON CONCRETE, CONCRETE MASONRY, EXPOSED CONCRETE AGGREGATE, AND CEMENT PLASTER

A. Apply water repellent in accordance with manufacturer's printed instructions.

B. Apply flood coat using low-pressure spray equipment.

C. Start at top of wall and work down using overlapping horizontal passes.

D. Hold spray head 8 to 10 inches from surface so saturation coat runs freely down wall 6 to 10 inches below point of application on most substrates.

E. Spray by traveling horizontally to ensure uniform coverage.

F. Overlap each following pass by centering spray head on bottom line of the previous pass.

G. Trigger gun off at end of each pass to avoid applying excessive amount of material. Do not over apply.

H. Avoid application in hot or windy weather as premature drying can cause whitish residue on walls.

3.04 FIELD QUALITY CONTROL

A. 20 days after application, test water repellent on CMU surfaces using RILEM Test Method No. 11.4:
   1. Contractor shall perform a 20-minute RILEM baseline test on dry untreated CMU units of each type to receive water repellent. Test results (water loss in milliliter) shall be compared to CMU units in walls after water repellent application.
   2. On water repellant coated CMU, a RILEM tube test resulting in 5 milliliter or less after 20 minutes is necessary to qualify for 5-year warranty.

B. Notify the Engineer and manufacturer at least 72 hours in advance of test.

C. Where tested wall areas fail to pass RILEM tube test, apply additional coat of water repellent on entire wall from corner to corner.

D. Test all locations where directed by the Engineer.

3.05 CLEANING

A. Concrete, concrete masonry, exposed concrete aggregate, and cement plaster: Clean drips, runs, and overspray residue while still wet, using detergent and water. Clean application and spray equipment with detergent and water immediately following use.

B. Brick, clay brick tile, brick veneer, stone, and wood: Clean drips, runs, and overspray residue with petroleum type thinner following application.

C. Clean application and spray equipment according to the manufacturer's recommendations.

D. Remove excess materials, equipment, and debris incidental to water repellent application upon completion.

3.06 PROTECTION

A. During application, protect water repellent treated and adjacent surfaces from damage.

B. Protect glass, aluminum, and other surfaces from overspray.

C. Protect concrete sidewalks from runoff. Soak with water immediately prior to application on adjacent walls.

D. Repair damaged areas promptly.

END OF SECTION

SECTION 07220

ROOF AND DECK INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Roof and deck insulation and associated accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. D41- Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
   3. D312 - Standard Specification for Asphalt Used in Roofing.

B. National Roofing Contractors Association (NRCA).

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Product data.

B. Samples. Include 6-inch square samples of each type and thickness of insulation required.

C. State thickness and R-value of insulation to be provided at each building.

D. Manufacturer's installation instructions: Include the following:
   1. Indicate special environmental conditions required for installation.
   2. Indicate adhesive recommendations.
   3. Indicate fastener recommendations and attachment pattern to meet specified FM 1-90 requirements.
   4. Indicate installation techniques.

E. Certificates:
   1. Certify that products meet or exceed specified requirements.
   2. Certify that insulation is approved by manufacturer for use with specified roofing materials.

F. Manufacturer's field reports.

G. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications:
   1. Manufacturer-approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.
   2. Committed to complying with manufacturer's specifications and NRCA recommendations.
   3. Committed to assuming undivided responsibility for roof insulation, roofing membrane and sheet metal flashing, and trim associated with roofing.

C. Product compatibility: Provide roofing manufacturer approved roof insulation.

D. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's instructions.

B. Label asphalt containers with certification of full compliance with requirements of ASTM D312, Table 1, and indicating equiviscous temperature, finished flowing temperature, and flash point.

C. Store roof system materials on pallets or dunnage at least 4 inches above ground and suitably covered to protect from weather.

1.06 SEQUENCING AND SCHEDULING

A. Apply no more insulation than can be completely covered with roofing membrane on the same day.

B. When installation of insulation and roof membrane cannot be completed within same day, install temporary water cutoffs at end of day's work and remove cutoffs prior to resumption of work.

1.07 WARRANTY

A. Furnished by roof membrane manufacturer, as specified in Section 07540 - Thermoplastic Polyolefin (TPO) Membrane.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Roof insulation system: As follows with UL Class A and FM Class 1A fire classification and meeting FM 1-90 wind up-lift requirements.
   1. Where 5-inch rigid foam roof insulation is indicated on the Drawings, insulation shall be as follows:
      a. First layer: 1.5-inch thick foam insulation having an R-Value of 9.0.
      b. Vapor retarder.
      c. Second layer: 3.4-inch thick foam insulation having an R-Value of 21.1.
      d. Total system thickness shall be 4.9 inches and have a minimum R-Value of 30.0.
   2. Where tapered rigid foam insulation is indicated on the Drawings, insulation shall be as follows:
      a. Multiple layer insulation, comprised of layers of flat and tapered rigid foam roof insulation, built up to provide a taper, sloped to drains, of 1/4-inch per foot minimum.
      b. Minimum insulation thickness at roof drains shall be 1-1/2 inches.
      c. Provide drainage pattern as indicated on the Drawings.

2.02 MATERIALS

A. Vapor retarder: ASTM D2178, Type IV; asphalt impregnated glass fiber sheet with nominal tensile strength 30 percent higher than required by ASTM D2178 for Type IV felts:
   1. Manufacturers: One of the following or equal:
      a. John Manville, Inc., GlasPly Premier.
      b. Atlas Roofing Corp., equivalent product.

B. Rigid foam roof insulation:
   1. Closed cell polyisocyanurate foam core bonded to universal fiberglass reinforced facers.
   2. Utilizing environmentally compliant blowing agent.
   3. Manufacturers: One of the following or equal:
      a. Johns Manville, Inc., ENRGY 3.
      b. Atlas Roofing Corp., ACFoam II.

C. Tapered foam roof insulation:
   1. Closed cell polyisocyanurate foam core bonded to universal fiberglass reinforced facers.
   2. Utilizing environmentally compliant blowing agent.
   3. Manufacturers: One of the following or equal:
      a. Johns Manville, Inc., Tapered ENRGY 3.
      b. Atlas Roofing Corp., Tapered ACFoam II.

D. Mineral board: Factory fabricated, 1/2-inch thick, glass mat faced, noncombustible, moisture resistant, silicone treated, gypsum core panel.
   1. Manufacturers: The following or equal:
      a. Georgia-Pacific, Dens-Deck Roof Board.

E. Roof crickets and saddles: Tapered Perlite Roof Insulation or as otherwise recommended by roofing manufacturer to meet warranty requirements.

2.03 ACCESSORIES

A. Screw fastener system for steel decks:
   1. Self-drilling and self-tapping, zinc plated or stainless steel screws, sized for 1/2- to 3/4-inch exposure on exposed to view underside of deck, with minimum 3-inch square or diameter ribbed steel stress plates, hot-dip galvanized with minimum G-60 coating in accordance with ASTM A123.
   2. Manufacturers: One of the following or equal:
      a. Tru Fast.
      b. TW Buildex.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that deck is properly graded to outlets.

B. Verify that deck surfaces are clean, dry, and where required, coated with primer.

3.02 PREPARATION

A. Embed 1 ply of roofing felt over roof drains and minimum 6 inches over adjacent surface in solid uniform layer of plastic cement.

3.03 HEATING OF ASPHALT AND APPLICATION TEMPERATURES

A. Equip kettles and tankers with accurate, fully readable thermometers.

B. Do not heat asphalt to or above their flash points.

C. Avoid heating at or above finished flowing temperature.

D. When accepted, heat above finished flowing temperature for no more than 4 hours.

E. Apply asphalt at maximum 25 degrees Fahrenheit below finished flowing temperature or above equiviscous temperature.

F. Do not cut or alter bitumens.

3.04 INSTALLATION OVER STEEL DECK

A. Install roof insulation in accordance with manufacturer's specifications.

B. Secure wood nailers to roof deck adjoining eaves, at roof curbs for attachment of flashing and counterflashing, and at other locations indicated on the Drawings.
   1. Nailers shall be built of pressure-treated wood to match the thickness of the insulation.

C. Apply first layer of roof insulation with long joints continuous, either parallel or at right angles to ribs of deck.

D. Form joints parallel to ribs over solid bearing.

E. Stagger end joints.

F. Secure with approved mechanical fasteners in FM I-90 pattern:
   1. Space fasteners as recommended by insulation manufacturer.
   2. Drive fasteners through tin caps or plastic fastener/cap assemblies, unless they are provided with integral flat cap not less than 1 inch across.
   3. Install screw fastener system in top rib of steel deck in accordance with manufacturer's instructions. Where underside of metal deck is exposed to view, size fasteners to penetrate deck from 1/2- to 3/4-inch, unless otherwise recommended by fastener manufacturer.

G. Vapor retarder:
   1. Apply one 18 inch wide layer of vapor retarder, then continue with full 36-inch widths, lapping each course 2 inches over preceding one.
   2. Install each felt so felt is firmly and uniformly set, without voids, into hot asphalt applied just before felt at nominal uniform 23 pounds per square over entire surface.
   3. Turn up edges of felts on, but not connected to, vertical surfaces and extend beyond roof edges for coverage sufficient to permit minimum 4 inch return over top surface of insulation.

H. Apply second layer of roof insulation with both long and short joints offset from joints of first layer. Firmly set in full width mopping of hot asphalt applied at approximately 33 pounds per square.

I. Install cant strips at curbs, parapets, and intersections of roofs and vertical walls, when recommended by membrane manufacturer. Place on top of insulation and set in solid mopping of asphalt.

J. Roof crickets:
   1. Install to maintain ¼ inch per foot slope where roof cricket meets sloped roof, and as otherwise required to obtain roof warranty. Set in full mopping of hot asphalt. Feathered edges of crickets and tapered insulation shall be formed of perlite or fiber board.
   2. Mop 12-inch wide felt strip into solid asphalt at valley formed by installation of roof crickets to provide additional membrane reinforcement.

K. Before application of roofing, turn over and solidly mop projecting felt to insulation at vertical surfaces and edges.

L. Do not leave insulation exposed to weather.

3.05 FIELD QUALITY CONTROL

A. Roof insulation which becomes wet or damaged shall be removed and replaced with solid, dry insulation, unless installer provides written acceptance of the

damaged insulation from the roofing manufacturer, whose warranty shall cover the system.

B. Inspections: Roof membrane manufacturer, whose warranty shall cover complete roof assembly, shall provide supervision and inspection necessary to secure warranty.

END OF SECTION

SECTION 07260

VAPOR RETARDERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Vapor retarder.
   2. Pressure sensitive tape or mastic.

B. Scope includes: Chlorine Building (Area 63), Caustic Soda Building (Area 65), and as required by Section 09960 - High Performance Coatings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slab.
   2. E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.

1.03 SUBMITTALS

A. Product data including manufacturer's installation instructions for placement, seaming, and penetration repair.

B. ASTM E1745 test results by third-party testing agency.

PART 2 PRODUCTS

2.01 VAPOR RETARDER

A. Polyethylene film:
   1. In accordance with ASTM E1745, Class A.
   2. Vapor permeance in accordance with ASTM E1745, Section 7.1: 0.01 perms or less.

B. Manufacturers: One of the following or equal:
   1. Reef Ind., VaporGuard.
   2. Stego Ind., LLC, Stego Wrap.

2.02 PRESSURE SENSITIVE TAPE OR MASTIC

A. Use manufacturer's recommended pressure sensitive tape or mastic.

PART 3 EXECUTION

3.01 PREPARATION

A. Level and compact base material.

B. Remove all sharp and protruding objects from surfaces to receive vapor retarder.

3.02 INSTALLATION

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

B. Place vapor retarder in greatest widths and lengths practicable.

C. Overlap joints a minimum of 6-inches and seal with manufacturer's pressure-sensitive tape.

D. Lap vapor retarder/barrier over footings and seal to the foundation wall.

E. Seal punctures and tears with patch created from vapor barrier material secured with pressure sensitive tape.

F. Around pipes: Use manufacturer's recommended pressure sensitive tape or mastic.

3.03 PROTECTION

A. Protect vapor retarder so that other construction activities do not puncture, damage, or otherwise cause deterioration of vapor retarder.

B. Repair damage to vapor retarder with pressure sensitive tape.

C. Cut vapor retarder around pipes and conduit piercing vapor retarder with undersized holes and apply manufacturer recommended pressure sensitive tape or mastic to insure maximum vapor retarder effectiveness.

END OF SECTION

SECTION 07540

THERMOPLASTIC POLYOLEFIN (TPO) MEMBRANE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Mechanically attached, 60 mil thermoplastic polyolefin membrane, white, scrim-reinforced fleece back membrane roofing system.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7 - Hazard Tool.

B. ASTM International (ASTM):
   1. D751 - Standard Test Methods for Coated Fabrics.
   2. E108 - Standard Test Methods for Fire Tests of Roof Coverings.

C. Single Ply Roofing Industry (SPRI):
   1. SPRI WD-1 - Wind Design Standard Practice for Roofing Assemblies.

D. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Product data: Include specifications and flashing details.

B. Detail drawings: Provide roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Crickets, saddles, and tapered edge strips, including slopes.
   4. Insulation fastening and adhesive patterns.
   5. Mechanical equipment, skylights, conduit, and other penetrations.

C. Samples:
   1. For each product specified.
   2. Each type of felt: 8 inches square.

D. Manufacturer's Installation Instructions.

E. Certificates:
   1. UL listings.
   2. Letter of certification from the manufacturer certifying the roofing contractor is authorized to install the manufacturer's roofing system, include certified foreman and training dates.
   3. Indicating membrane thickness from the membrane manufacturer.

F. Installer Authorization: Letter or certificate signed by roofing system manufacturer certifying that installer is approved, authorized, or licensed by manufacturer to install roofing system.

G. Maintenance manual: Include repair instructions.

H. Prior to beginning the Work of this Section:
   1. Submit sample warranties.
   2. Submit the final System Assembly Letter issued by manufacturer indicating that the products and system to be installed shall be eligible to receive the specified manufacturer's guarantee when installed by a certified contractor in accordance with manufacturer application requirements, inspected and approved by an authorized manufacturer representative.
   3. Submit the Guarantee Application Confirmation document issued by manufacturer indicating that the project has been reviewed for eligibility to receive the specified guarantee/warranty and that the project is registered.

I. Upon substantial completion:
   1. Submit final warranties.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer’s product and that is eligible to receive the specified manufacturer’s guarantee/warranty.

C. Source Limitations:
   1. Obtain all components from the single source roofing manufacturer guaranteeing the roofing system.
   2. All products used in the system shall be labeled by the single source roofing manufacturer issuing the guarantee.

D. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.

E. Verify existing roof, deck insulation, and roof specialties and accessories in Section 07700 - Roof Specialties are compatible with membrane roofing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original unopened containers.

B. Label containers with manufacturer's name, brand name, installation instructions, and identification of items.

C. Each container or bulk shipping ticket for asphalt shall indicate the equiviscous temperature, finished blowing temperature, and the flash point.

D. Store materials out of direct exposure to the elements.

E. Store roll goods on end on a clean flat surface.

F. Protect materials against moisture.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not apply roofing membrane during inclement weather or when air temperature may fall below 40 degrees Fahrenheit.

B. Do not apply roofing membrane to damp or frozen deck surface.

C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.

1.07 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Special warranty:
   1. Manufacturer's warranty:
      a. Minimum 20 years to correct defective roofing materials, including installation.
      b. Damage from hail up to 4-inches in diameter shall be included as part of the manufacturer's warranty.
   2. Roof Installer's warranty: Minimum 2 years to correct defective workmanship.
   3. Warranty rider for hail enhancement:
      a. Hail: For hail up to 1 inch.
      b. Moderate hail: 1.5.
      c. Severe hail: For hail up to 2 inches.
   4. Warranty rider for punctures:
      a. Provides 8 hours per year for repair of punctures.
      b. Provides 16 hours per year for repair of punctures.
      c. Provides 32 hours per year for repair of punctures.
   5. Warranty rider for ponding water.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Carlisle Corp., Sure-Weld Roofing System.
   2. Johns Manville, JM TPO Roofing Systems.

2.02 D TYPE

A. Type: Mechanically attached, 60 mil, reinforced thermoplastic polyolefin (TPO) membrane assemblies.

B. Membrane color: White.

2.03 DESIGN AND PERFORMANCE CRITERIA

A. General: Installed roofing membrane system shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.

C. Installer shall comply with current code requirements based on authority having jurisdiction.

D. Design uplift pressures:
   1. In accordance with building code: As specified in Section 01410 - Regulatory Requirements.
   2. In accordance with SPRI WD-1.
   3. In accordance with ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE.SEI 7-16).

E. Wind uplift performance:
   1. As specified in Section 01850 - Design Criteria.
   2. Roofing system shall be identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist wind uplift pressure calculated in accordance with ASCE 7.

F. Wind pressure at each element: As indicated on the structural Drawings.

G. Roof live load, roof dead loads and snow load: As indicated on the structural Drawings.

H. Fire-test-response characteristics:
   1. Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction.
   2. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

I. Fire hazard classification:
   1. UL Class A.

J. Exterior fire-test exposure:
   1. ASTM E108, Class A for application and roof slopes indicated.

2.04 COMPONENTS

A. Scrim-Reinforced Thermoplastic Polyolefin (TPO) Sheet: 60 mil, scrim-reinforced, white, fleece back membrane 4**,** 10-foot wide maximum by appropriate length conforming to following minimum physical properties:
   1. Tensile strength: Minimum of 300 pounds per foot as tested in accordance with ASTM D751.
   2. Tear strength: Minimum 45-60 pounds when tested in accordance with ASTM D751.

B. Flashing, bonding adhesive, sealant, primer, seam caulk, insulation replacement, and fasteners: Membrane manufacturer approved.

2.05 WALKWAY INSTALLATION

A. Sarnatred-V: Install walkway product in locations indicated, adhere (except edges) to deck sheet, and hot-air weld edges.

B. Crossgrip XTRA: Install walkway product in locations indicated, loose-lay on deck sheet, and connect butt ends together.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification the following:
   1. Proper installation of treated curbs, wood nailers, insulation, cants, and crickets.
   2. Deck is properly graded to outlets. Build up potential birdbaths.
   3. Deck surfaces are dry, clean, smooth, and free of sharp edges and debris.

3.02 PREPARATION

A. Prepare substrate to receive roofing system in accordance with roofing manufacturer's instructions.

B. Install flashings and similar accessory items in accordance with manufacturer's instructions.

C. Sweep surface to be covered clean of debris, dirt, or other sharp objects.

D. Prime metal flanges, concrete and masonry surface, and concrete roof deck to receive membrane roofing with a uniform coating of asphalt primer.

3.03 INSTALLATION

A. Install roofing in accordance with manufacturer's instructions and warranty.

B. Install perimeter sheets.

C. Lay field sheets with long edges perpendicular to roof slope, with edge of roll aligned with perimeter sheets.

D. Membrane shall be bonded to the substrate with manufacturer's approved adhesives. Overlap fastened edges of installed membrane by approximately 5-1/2 inches at fastening plates and 2 inches at end roll sections.

E. Seal non-factory cut edges with seam caulk.

F. Fasten and finish perimeter in accordance with membrane manufacturer's standard termination details.

3.04 FIELD QUALITY CONTROL

A. Arrange for manufacturer's inspection of completed installation in the presence of the Engineer and the Owner.

3.05 PROTECTION

A. Before the end of each working day or before application is interrupted by precipitation, seal exposed sheet edges along laps and around drains, projections, and upstands.

B. Build cutoffs using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Completely remove cutoffs prior to the resumption of roofing.

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: flashing, sheet metal, and associated accessories.

1.02 REFERENCES

A. Aluminum Association (AA).

B. ASTM International (ASTM):
1. A240 - Standard Specification for Chromium and Chromium-nickel Stainless Steel Plate, Sheet, and Strip For Pressure Vessels and General Applications.
2. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. B32 - Standard Specification for Solder Metal.
4. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
5. B221 - Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
6. B224 - Standard Classification of Coppers.
7. B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
8. B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
9. D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
10. D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

C. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show fabrication details, material profiles, connections, jointing pattern, jointing details, fastening methods, isolation methods, and installation details.

C. Manufacturer's Installation Instructions.

1.04 SEQUENCING AND SCHEDULING

A. Coordinate sheet metal installation with installation of materials specified in Sections 03102 - Concrete Formwork, 04220 - Concrete Unit Masonry, 07900 - Joint Sealants,15050 - Common Work Results for Mechanical Equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Stack preformed material to prevent twisting, bending, or abrasion, and to provide ventilation.

B. Prevent contact with materials during storage which may cause discoloration, staining, or damage.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aluminum extrusions: ASTM B221, alloy 6063-T42.

B. Aluminum sheet: ASTM B209, 5005-H14 alloy and temper; minimum 32 mils thick, mill finish.

C. Galvanized steel sheet: ASTM A653, G-90 minimum 24 gauge thick, with 1.25 ounce coating.

D. Stainless steel: ASTM A240, Type 304 or Type 316 as indicated on the Drawings, soft temper; minimum 26 gauge thick; smooth finish.

2.02 ACCESSORIES

A. Fasteners and metal washers: Types best suited for purpose, of same material as sheet metal being fastened or of composition that will not support electrolysis, such as Type 18-8 stainless steel for fastening aluminum.

B. Sealer washers: Rubber type, minimum 0.040 inch thick.

C. Underlayment: ASTM D226; Number 30 asphalt saturated roofing felt. Polyethylene, 6 mil thick.

D. Metal primer.

E. Protective backing paint: Bituminous.

F. Slip sheet: Rosin sized building paper.

G. Bedding compound: Rubber-asphalt type.

H. Roof cement: ASTM D4586, plastic asphaltic cement.

I. Solder: ASTM B32.

2.03 FABRICATION

A. Form sheet metal true to shape, accurate in size, square, and free from distortion or defects.

B. Form rises and angles into flashing true and straight, with exposed surfaces free from waves and buckles.

C. Fabricate cleats and starter strips of same material as sheet, minimum 3 inches wide, interlockable with sheet.

D. Form pieces in longest practical lengths. Size and space joints to provide adequate movement for thermal expansion and contraction.

E. Hem exposed edges on underside 1/2 inch; miter and seam corners.

F. Form material with flat lock seams.

G. Solder and seal metal joints. After soldering, remove flux. Wipe and wash solder joints clean.

H. Fabricate corners from 1 piece with minimum 18inch long legs; seam for rigidity, seal with sealant.

I. Fabricate vertical faces with bottom edge formed outward 1/4 inch and hemmed to form drip.

J. Fabricate flashings to allow toe to extend a minimum 2inches over roofing Return and break edges.

K. Form pitch pocket pans large enough to provide minimum 2 inch clearance between penetrating object and upstand, 4inch upstands and 4 inch flanges.

2.04 FINISH

A. Backpaint concealed metal surfaces with protective backing paint to minimum dry film thickness of 15 mil.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.

B. Verify membrane termination and base flashings are in place, sealed, and secure.

3.02 INSTALLATION

A. Install flashing and sheet metal in accordance with AA and SMACNA references, and when in connection with roofing, roofing manufacturer's specifications.

B. Install sheet metal to even smooth, sound, thoroughly clean and dry surfaces, free from defects that could affect installation.

C. Install flashings where necessary to provide leakproof conditions.

D. Isolate dissimilar metals from direct contact with protective backing paint.

E. Install starter, edge strips, and cleats before starting installation.

F. Perform cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate work of other sections.

G. Install sealer washers under metal washers or fastener heads where weathertightness is required.

H. Install surface mounted reglets true to lines and levels. Seal top of reglets with sealant.

I. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations acceptable to the Engineer.

J. Seam and seal joints. Make connections watertight and weathertight.

K. Apply roof cement compound between metal flashings and felt flashings.
   1. Fit flashings tight in place.
   2. Make corners square, surfaces true and straight in planes, and line accurate to profiles.

L. Seal metal joints watertight.

END OF SECTION

SECTION 07700

ROOF SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Manufactured roof specialties and accessories, including the following:
   1. Metal coping.
   2. Metal gravel stop fascia.
   3. Equipment curbs and supports, and associated accessories.

1.02 REFERENCES

A. Single Ply Roofing Industry (SPRI):
   1. ES-1 - Test Standard for Edge Systems Used with Low Slope Roofing Systems.

1.03 SUBMITTALS

A. Product data: Include finish and color options.

B. Shop drawings. Include equipment curbs and supports details.

C. Certifications: Certify that curbs are capable of supporting the specified equipment including loads specified in Section 01850 - Design Criteria.

D. Samples: Include finish and color samples.

E. Manufacturer's Installation Instructions.

F. Warranties.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

1.06 WARRANTY

A. Provide manufacturers' standard warranties that warranty against defects for longer than 1 year.

PART 2 PRODUCTS

2.01 METAL COPINGS

A. Manufacturers: One of following or equal:
   1. Peterson Aluminum Corp., Pac-Lok.
   2. MM Systems Corp., Snap-Lok.
   3. OMG Roofing Products, Permasnap.

B. Characteristics:
   1. Capable of direct attachment to top of masonry walls.
   2. In accordance with SPRI ES-1.
   3. In accordance with codes as specified in Section 01410 - Regulatory Requirements.
   4. Capable of counterflashing roofing.

C. Copings:
   1. Material: Aluminum, minimum 0.063 inch thick.
   2. Width: To suit wall thickness.
   3. Length: 144 inches.
   4. Face heights: Sufficient to conceal nailers or roof decking.
   5. Corners: Mitered and welded with minimum 24-inch legs.
   6. Finish: Kynar® 500, resin-base color coating. Color as selected from manufacturer's standard color line.

D. Splice plates: Same materials, width, face heights, and finish as coping, 6 inches long.

E. Seal strips: Extruded Butyl with protective paper.

F. Anchor plate: Galvanized steel. Same width, face height as coping, approximately 12 inches long.

G. Fasteners and anchors: Manufacturer's recommendation.

2.02 GRAVEL STOPS FASCIA FOR SINGLE PLY ROOFING

A. Manufacturers: One of the following or equal:
   1. Peterson Aluminum Corp., Pac-1-Ply.
   2. MM Systems Corp., SLF- Series II.
   3. OMG Roofing Products, TerminEdge.

B. Fascia up to 8 inches high:
   1. Material: Aluminum, minimum 0.040-inch thick.
   2. Length: Maximum practical.

3. Face height: Sufficient to conceal edges of nailers or roof decking.
4. Corners: Mitered and welded with minimum 24-inch legs.
5. Finish: Kynar® 500, resin-base color coating. Color as selected from manufacturer's standard color line.

C. Splice plates: Same materials, width, face heights, and finish as coping.

D. Cant dams and hold-down clips: Galvanized steel, minimum 24 gauge, continuous.

E. Screws: Stainless steel.

2.03 EQUIPMENT CURBS

A. Definition:
1. Four-sided curb supporting the footprint (outline) of the roof-mounted equipment.
2. It may surround a full deck opening as at a duct or skylight, a partial deck opening as at supply and return ducts below an A/C unit, or there may be no deck opening within the curb as at a side discharge A/C unit.

B. Manufacturers: One of following or equal:
1. Equipment curbs provided by the equipment manufacturer as specified in the equipment sections.

C. Design requirements:
1. Capable of supporting equipment loads.
2. Size: Curb width as indicated on the Drawings or as otherwise recommended by the equipment manufacturer.
3. Curb manufacturer to coordinate curb capacity and width with the equipment supplier.

D. Material and fabrication:
1. Metal: Galvanized steel; gauge as required to suit equipment loads, minimum 18 gauge.
2. Rail profile: Straight, without cant.
3. Rail height: Minimum 12 inches at uniform thickness insulation and 15 inches at tapered insulation, including nailer , unless otherwise indicated on the Drawings.
4. Rail top: Level within 1/8 inch in 10 feet (adjust for roof slope).
5. Rail width: Width of nailer.
6. Rail reinforcement: Rolled tee bar at 24 inches on center.
7. Rail infill: Insulation, 3-pound density.
8. Nailer: Nominal 2 inch by width to suit equipment supported, pressure preservative treated wood, and manufacturer recommended species.
9. Base: Adequately sized to ensure proper anchoring.
10. Corners: Mitered and continuously welded with minimum 24-inch legs.

E. Accessories:
1. Curb liner: Minimum 22 gauge galvanized steel, spot welded to curb, to finish inside of curbs exposed to view from below.

2. Curb platform: Minimum 3/4-inch thick plywood platform over top of curb, capped with 20-gauge galvanized metal welded watertight to support open sled-based roof equipment, or as watertight closure over curbed opening for future equipment.
3. Metal roofing adapters: Fabricated to conform to exposed metal roofing-profile, overlapping deck by minimum 3 inches, with water diverters on flat area; watertight, continuous welds.

2.04 EQUIPMENT SUPPORTS

A. Definition: A linear rail or rails for mounting horizontal piping across the top of roof or for supporting roof equipment on legs.

B. Linear rails:
1. Manufacturers: One of the following or equal:
a. Pate Co., Model ES-2.
b. ThyCurb, Model TEMS.
c. Roof Products, Inc., Model RPES-3.

C. Material and fabrication:
1. Material: 14 gauge galvanized.
2. Rail profile: Straight, without cant profile.
3. Rail height: Minimum 12 inches including nailer at uniform thickness insulation and 15 inches at tapered insulation, including nailer , unless otherwise indicated on the Drawings.
4. Rail top: Level within 1/8 inch in 10 feet (adjust for slope of roof).
5. Rail width: Width of nailer.
6. Rail reinforcement: Rolled tee bar at 24 inches on center.
7. Rail infill: None.
8. Nailer: Nominal 2- by 4-inch , unless otherwise indicated on the Drawings, pressure preservative treated wood, manufacturer recommended species.
9. Base: Adequately sized to ensure proper anchoring.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install roof accessories and specialties accordance with manufacturers' instructions.

3.02 INSTALLATION OF METAL COPINGS

A. Accurately align and install metal copings with uniformly smooth vertical faces.

B. Attach anchor plate to top of wall at 72 inches on center.

C. Install splice plates on anchor plates at splice joints of coping. Install seal strips on top of plate and down face approximately 1/2 inch. Apply slight pressure on sealant to incur adherence to clean, dry splice plate. Remove protective paper from sealant.

D. Fully engage hook on front face of coping with front leg of anchor plates, pivot coping into position pressing firmly at rear over each anchor plate until hook on rear face of coping snaps into place.

E. Leave 1/4-inch joint between abutting ends at splice plates.

3.03 INSTALLATION OF GRAVEL STOPS

A. Locate joints in balanced pattern along each run, from end to end.

B. Overlap cant dams 1 inch. Nail to top of nailer at maximum 12 inches on center and face of nailer at maximum 24 inches on center, unless otherwise specified by roofing manufacturer.

C. Accurately align and install gravel stops with uniformly smooth vertical faces.

3.04 INSTALLATION OF EQUIPMENT CURBS AND SUPPORTS

A. Curbs: Install at roof mounted equipment where specified or indicated.

B. Supports: Install where indicated on the Drawings.

END OF SECTION

SECTION 07722

ROOF HATCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Thermally broken roof hatches.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

1.03 SUBMITTALS

A. Product data: Indicate general construction, configurations, and jointing methods.

B. Shop drawings: Show locations, sizes, fastening methods, and installation details.

C. Manufacturer's Installation Instructions.

1.04 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Special warranty:
   1. Duration: 5 years warranty on product defects.

PART 2 PRODUCTS

2.01 ROOF HATCHES

A. Manufacturers: One of the following or equal:
   1. The Bilco Co.
   2. Nystrom.

2.02 SINGLE LEAF FOR LADDER ACCESS

A. Size:
   1. Ships Ladder applications:
      a. Nominal size: 30-inches wide by 54-inches long.
      b. Cover opening angle minimum: 70 degrees.

B. Cover and curb:
   1. Material:
      a. Exterior surface and curb material:
         1) Minimum 11-gauge aluminum.

b. Interior surface material:
1) Minimum 18-gauge aluminum liner.
2) Fully covering cover insulation.

2. Cover:
a. Corners:
1) 3-inch beaded flange and welded.
2) Weathertight corners.
b. Insulation:
1) Nominal 3-inch polyiso in cover.

3. Curb:
a. Height: Minimum 12 inches.
b. Insulation: 3-inch thick polyisocyanurate on outside.
c. Interior and exterior shall be thermally broken to minimize heat transfer and resist condensation.
d. Flange: Minimum 5-1/2-inch with holes for fasteners, and welded, weathertight corners.
e. Curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners per manufacturer's recommendation.

4. Safety guardrail:
a. Manufacturers: One of the following or equal:
1) The Bilco Co., Model RL2.
2) Nystrom, SRCAY.
b. Rail material: Aluminum
c. Finish: Safety yellow powder coating.
d. Gate: Spring hinged and latched.

5. Curb and roofing interface:
a. Non-metal roofing:
1) Integral metal cap flashing.

C. Finish:
1. Aluminum hatches: Mill finish.

D. Hardware:
1. Heavy stainless steel pintle hinges.
2. Compression spring operators enclosed in telescopic tubes.
3. Positive snap latch with turn handles, both inside and outside.
4. Padlock hasps, both inside and outside.
5. Gasket:
a. EPDM rubber gasket adhered to the liner.
6. Automatic hold-open arm with red vinyl grip handle capable of 1-hand release.
1. Enclosed 2-point spring latch as recommended by manufacturer.

E. Latch hardware:
1. Hardware including latch assembly, inside and outside padlock hasps, arm guide bracket, lifting mechanism bracket, hinges, hinge pins, hold open arm, lock strike casting, springs, spring tubes, shoe castings, and fasteners.
2. Zinc chromate plated.

F. Fall prevention system and ships ladder:
1. As specified in Section 05500 - Metal Fabrications.

PART 3 EXECUTION

3.01 INSTALLATION

A. Hatch quantities and locations shall be as indicated on the Drawings.

B. Install roof hatches in accordance with manufacturer's instructions.
   1. Coordinate with installation of roofing system and related flashing.
   2. Provide weathertight installation.

C. Paint hatch as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Acrylic-Latex sealant.
   2. Precast concrete joint sealant.
   3. Silicone sealant.
   4. Synthetic rubber sealing compound.
   5. Synthetic sponge rubber filler.
   6. Related materials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. ASTM International (ASTM):
   1. C920 - Standard Specification for Elastomeric Joint Sealants.
   2. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
   4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

A. Product data.

B. Samples, include color selections.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Code date packages. Do not use material older than manufacturer’s published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer’s instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

A. Caulk joints prior to painting.

1.08 WARRANTY

A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

A. 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 made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      a. Control joint depth.
      b. Break bond of sealant at bottom of joint.
      c. Provide proper shape of sealant bead.
      d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options:
   1. Manufacturers: One of the following or equal:
      a. Tremco, Tremflex 834.
      b. Pecora Corp., Number AC-20.
      c. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198:
   1. Manufacturers: One of the following or equal.
      a. Henry Corp., Ram-Nek.
      b. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
   1. Manufacturers: One of the following or equal:
      a. Tremco, Proglaze.
      b. Pecora Corp., Number 864.
      c. Dow Corning, Number 795.
      d. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:
   1. Sika Corporation, Sikaflex 2c NS or SL
   2. Sika Corporation, Sikaflex 2c NS EZ Mix.
   3. Pacific Polymers, Elastothane 227R.

B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
   1. Base: Polyurethane rubber.
   2. Application time: Minimum 2 hours.
   3. Cure time: Maximum 3 days.
   4. Tack free time: Maximum 24 hours.
   5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
   6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.
   7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.

8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type C:
1. Manufacturers: The following or equal:
a. Tremco Presstite, No. 750.3 Ropax Rod Stock.
b. Nomaco, HBR Backer Rod

B. Characteristics:
1. Suitable for application intended.
2. Strength: As necessary for supporting sealing compound during application.
3. Resiliency: Resistance to environmental conditions of installation.
4. Bonding: No bonding to the sealing compound.
5. Structure: Cellular, prevents absorption of water.
6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify acceptability of joint dimensions, physical, and environmental conditions.

B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

A. Allow concrete to cure thoroughly before caulking.

B. Synthetic sponge rubber filler:
   1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
   2. Do not stretch filler beyond its normal length during installation.

C. Caulking:
   1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.
   2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

D. Synthetic rubber sealing compound:
   1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
   2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.

F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

J. Do not stretch filler beyond normal length during installation.

K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.

B. Caulking, joints, and sealing:
   1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
   2. Install pipe and conduit in structures as indicated on the Drawings.
   3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.

4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
5. Complete caulking prior to painting.
6. Verify that concrete is thoroughly cured prior to caulking.
7. When filler compressible material is used, use untreated type.
8. Apply caulking with pneumatic caulking gun.
9. Use nozzles of proper shape and size for application intended.
10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

A. Clean surfaces adjacent to sealant as work progresses.

B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

A. Acrylic latex:
   1. Use where indicated on the Drawings.
   2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

B. Silicone:
   1. Use where indicated on the Drawings.
   2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
   3. Door threshold bedding.
   4. Moist or wet locations, including joints around plumbing fixtures.
   5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
   6. Plenum joints.

C. Synthetic rubber sealing compound, non-sag Type II:
   1. Use where indicated on the Drawings.
   2. Water-bearing and earth-bearing concrete structures.
   3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.

4. Joints between sheet metal flashing and trim.
5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
8. Expansion and control joints in masonry vertical surfaces.

D. Synthetic rubber sealing compound, self-leveling Type I:
1. Use where indicated on the Drawings.
2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
4. Pavement joints.
5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

A. Adhesion testing:
1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
d. Building expansion joints: 1 test per every 500 LF of joint sealed.
e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel Fire Resistive Rated and Non-Fire Resistive Rated:
   1. Doors.
   2. Door frames.
   3. Window frames
   4. Combination door frames and window frames with mullions, muntins, and transom bars.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A250.6 - Hardware on Steel Doors (Reinforcement Application).
   2. A250.8 - Recommended Specification for Standard Steel Doors and Frames.

B. ASTM International (ASTM):
   1. A653 - Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   3. 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.
   4. 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.
   5. E413 - Classification for Rating Sound Insulation.

C. National Association of Architectural Metal Manufacturers (NAAMM)/Hollow Metal Manufacturers Association (HMMA):
   1. HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames.

D. National Fire Protection Association (NFPA):
   1. 80 - Standard for Fire Doors and Other Opening Protectives.
   2. 252 - Standard Methods of Fire Tests of Door Assemblies.

E. Steel Door Institute (SDI):
   1. SDI-111 - Recommended Details for Standard Steel Doors, Frame, Accessories and Related Components.
   2. SDI-117 - Manufacturing Tolerances Standard Steel Doors and Frames.

F. Underwriters' Laboratories, Inc., (UL):
   1. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
   2. UL 102 - Sustainability Assessment for Swinging Door Leafs.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show the following with references to the Engineer's door marks and hardware groups:
   1. Location of door and frame types.
   2. Details of fabrication, including core construction, glass lights, louvers, weatherstripping, and factory finish for each door.
   3. Cutouts and reinforcements for hardware.
   4. Methods of installation and anchorage to adjacent construction.

C. Certificates documenting:
   1. Fire-rated units have been successfully tested as specified in this Section.

D. Manufacturer's instructions: Submit manufacturer's installation instructions.

E. Pre-Submittal Conference:
   1. Conduct conference in compliance with requirements in Section 01312 - Project Meetings with attendance by representatives of Supplier, Installer.
   2. Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

1.04 QUALITY ASSURANCE

A. Testing agency qualifications: Approved by ultimate enforcing authority for the Project; regularly engaged in inspection of materials and workmanship at factory.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Before delivery, identify type and size of each door and frame in such a way that markings will not damage finish.

B. Preassemble doorframes in shop and deliver to Project site with spreader bar at sill or tie them in pairs to form box.

C. Protect doors and frames with resilient packaging sealed with heat shrunk plastic. Break seal on-site to permit ventilation.

D. Protect doors and frames during shipment and storage to prevent warping, bending, and corrosion.

1.06 SEQUENCING AND SCHEDULING

A. Ensure timely delivery of reviewed hardware schedule and hardware templates such that no delay occurs in the work of the Contract.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet steel: ASTM A1008, commercial quality, level, cold rolled steel, or ASTM A1011, hot rolled, pickled and oil rolled steel. Galvanize by hot-dip process with zinc-coating in accordance with ASTM A924 or with ASTM A653 and the coating designation A60 or G60.

B. Clips, bolts, screws, and rivets: sized as recommended by manufacturer.

C. Primer: Rust- inhibitive epoxy primer compatible with high-solids epoxy finish coating system as specified in Section 09960 - High-Performance Coatings.

D. Touch-up materials: Primer as recommended by manufacturer.

E. Door hardware: As specified in Section 08710 - Door Hardware.

F. Grout: As specified in Section 04220 - Concrete Unit Masonry.

G. Glass and glazing materials: As specified in Section 08800 - Glazing.

2.02 DOOR AND FRAME TYPES

A. Interior doors: ANSI 250.8, Grade III, Model 3 or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 18-gauge face sheets.

B. Exterior doors: ANSI 250.8, Grade III, Model 3, or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 16-gauge face sheets.

C. Interior frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames, minimum 16-gauge, sizes and shapes as indicated on the Drawings.

D. Exterior frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames HMMA 861, except minimum 14-gauge sizes and shapes as indicated on the Drawings.

E. Sound-rated (acoustical) assemblies: Provide door and frame assemblies fabricated as sound-reducing type, tested in accordance with ASTM E90, and classified in accordance with ASTM E413:
   1. Unless otherwise indicated, where sound-rated doors are scheduled, provide acoustical assemblies with sound ratings of Sound Transmission Class (from ASTM E413) (STC) 33 or better.

2.03 FABRICATION OF FRAMES

A. Galvanize all frames installed in exterior openings.

B. Frames: Sheet steel, integral type, welded continuous to full depth of frames with minimum 5/8-inch deep stops, unless otherwise indicated on the Drawings.

C. Hardware reinforcements: Fabricate according to SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Jamb Anchors: As required for adjacent wall construction, minimum 3 per jamb, unless otherwise indicated on the Drawings.

E. Floor anchors: Fixed type, except where adjustable anchors are indicated on the Drawings, 1 per jamb, with minimum 2 holes for anchorage. Where floor fill occurs, terminate bottom of frames at indicated finished floor level and support by adjustable extension clips resting on and anchored to structural slabs.

F. Anchors at masonry: Adjustable strap and stirrup, minimum 16-gauge corrugated or perforated steel at maximum of 30 inches on center and extending minimum 8 inches into masonry.

G. Anchors at previously placed concrete: Countersink machine screws through the frame into expansion devices spaced at maximum 30 inches on center.

H. Anchors at structural steel framing: Welded or otherwise securely fastened with stainless steel screws.

I. Anchors for fire resistive frames: Conform to requirements of labeling authority having jurisdiction.

J. Masonry angle stiffeners: Factory welded into heads of frames for installation in openings more than 48 inches wide.

K. Mullions, muntins, and transom bars: Minimum 18-gauge, tubular sheet steel matching, and butt-welded to head and jamb members.

L. Removable stops: Fasten at approximately 12 to 16 inches on center.

2.04 FABRICATION OF DOORS

A. Galvanize all doors installed in exterior openings.

B. Reinforce face sheets with steel rib stiffeners, spaced at maximum 6 inches apart, and securely attached to face sheets by spot welds at maximum 5 inches on center.

C. Fill voids between face sheets and stiffeners with fiberglass insulation having a minimum density of 0.8 pounds per cubic foot.

D. Edges: Full weld without visible joints. Bevel striking edge 1/8 inch in 2 inches.

E. Door cores:
   1. Stiffeners: Vertical steel ribs formed from minimum 22-gauge plain sheet steel, spaced at maximum 6 inches apart and securely attached to face sheets by spot welds at maximum 5 inches on center.
   2. Core fillers: Insulation, minimum 0.60 pound density noncombustible type, installed in spaces between stiffeners for full height of door; labeled door core material shall conform to requirements of labeling authority.

F. Tops and bottoms of doors: Close with continuous recess steel channel of minimum 16-gauge, extending full width of door and spot welded to both faces.

G. Tops and bottoms of exterior doors: Flush closing channels welded to make tops and bottoms waterproof with weep holes for escape of moisture.

H. Hardware reinforcements: Fabricate according to SDI A250.6 with reinforcing plates from same material as door face sheets.

I. Astragals:
   1. Install on active leaf of double doors in accordance with UL listing requirements for fire resistive ratings as indicated on the Drawings, and for exterior pairs of doors.
   2. Do not install on doors swinging in pairs with rating of 90 minutes or less in means of egress where both leaves are required to provide building code required exiting widths.
   3. Do not provide astragal cutouts for hardware operations.

J. Astragal clearances for fire resistive rated doors:
   1. Door bottoms at doors designated to receive non-combustible threshold: Not to exceed 3/8 inch between threshold and door bottom.
   2. Door bottoms where there is no threshold: Maximum clearance between door and floor not to exceed 1/2 inch.
   3. Door bottoms at doors designated to receive combustible floor coverings: Not to exceed 1/2 inch between floor covering and door bottom.
   4. Clearance between door and frame and between meeting edges of pairs of doors: Not to exceed 1/8 inch.

K. Astragal clearances for non-fire resistive rated doors: Same as fire resistive rated doors, unless otherwise indicated on the Drawings.

2.05 FABRICATION OF FIRE RATED DOORS AND FRAMES

A. Fabricate to meet requirements of the building code as specified in Section 01410 - Regulatory Requirements, UL 10C, UL 102, and NFPA 252, except hose stream test shall not be required for opposite swing double egress exit doors and for doors of fire endurance rating of less than 45 minutes with or without approved glass lites.

B. Temperature rise requirements of doors at exit enclosures and exit passageways: Maximum transmitted temperature end point of less than 450 degrees Fahrenheit above ambient at end of 30 minutes when tested in accordance with the building code as specified in Section 01410 - Regulatory Requirements.

C. Apply approved testing agency labels on fire rated doors and frames.

D. Fabricate oversized fire rated doors in accordance with requirements for ratings indicated on the Drawings.

2.06 LOUVERS

A. As specified in Section 08910 - Louvers.

2.07 LIGHT OPENINGS AND GLAZING

A. Materials:
   1. As specified in Section 08800 - Glazing.
   2. As specified in 08810 - Fire Rated Glazing and Framing Systems.

B. Stops and moldings:
   1. Provide stops and moldings around glazed lites where indicated.
   2. Form corners of stops and moldings with butted or mitered hairline joints at fabricator’s shop.
   3. Fixed and removable stops to allow multiple glazed lites each to be removed independently.
   4. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.

C. Moldings for glazed lites in doors and loose stops for glazed lites in frames:
   1. Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.

D. Fixed frame moldings:
   1. Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.
   2. Provide fixed frame moldings and stops on outside of exterior and on secure side of interior doors and frames.

E. Preformed metal frames for light openings:
   1. Manufacturer's standard frame formed of 0.048-inch-thick, cold-rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated.
   2. Match pre-finished door paint color where applicable.

2.08 ACCESSORIES

A. Mullions and transom bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout guards: Formed from same material as frames, not less than 0.016 inches thick.

C. Silencers:
   1. Drill single leaf doorframe jamb stops for minimum 3 silencers.
   2. Drill double-leaf doorframe head stops for minimum 2 silencers.
   3. Do not drill doorframes for silencers when weatherstripping is to be installed.

2.09 FINISHING

A. Thoroughly clean surfaces of oil, grease, and other impurities; touch-up abraded galvanizing; and chemically etch.

B. Fill irregularities and sand smooth finish surface. Apply 1 coat of manufacturer's standard rust inhibitive baked-on primer.

C. Finish painting: High solids epoxy polyurethane system:
   1. Interior doors in non-corrosive environment: As specified in Section 09910 - Painting.
   2. Exterior doors and interior doors in corrosive environments: As specified in Section 09960 - High-Performance Coatings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine reviewed hardware schedules and verify proper coordination of hardware and doors and frames.

B. Examine opening locations and verify the following:
   1. Correctness of dimensions, backing, or support conditions.
   2. Absence of defects that would adversely affect frame or door installation.

3.02 INSTALLATION

A. Install doors and frames in accordance with approved shop drawings and manufacturer's instructions.

B. Frames:
   1. Set accurately in position, plumb, align, and attach securely to structure.
   2. Set in place before construction of adjacent masonry or framed walls.
   3. Anchor frames to previously placed concrete.
   4. Set frames before removing spreader bars.
   5. Fully grout frames in masonry as the Work progresses.
   6. Grout frames at concrete through keyways provided at head and jambs.

C. Doors:
   1. Install at correct openings, ensure smooth swing and proper closure with frame.

D. Fire resistive frames and doors:
   1. Install to conform to NFPA 80 for fire resistive rated class as indicated on the Drawings.

E. Door hardware:
   1. Install in accordance with Section 08710 - Door Hardware.
   2. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

F. Separate or isolate dissimilar metals with neoprene gaskets, sleeves, and washers, or with coatings acceptable to the Engineer.

3.03 TOLERANCES

A. Manufacturing and installation tolerances: As indicated on the Drawings or in conformance with SDI 117 as minimum.

3.04 ADJUSTING AND CLEANING

A. Prime coat touch-up: Immediately after installation, sand smooth and touch-up rust areas, and other areas where primer has been damaged, with prime touch-up paint.

B. Make adjustments as required for correct, proper, and free function and smooth operation without binding of hardware or doors and frames.

C. Protect doors and frames from damage to surface or profile.

END OF SECTION

SECTION 08320

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire-rated floor access doors.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR 1910 - Occupational Safety and Health Standards.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings that include the following:
   1. Floor access door installation recommendations.
   2. Locations of floor access doors.
   3. Door size and configuration.
   4. Live load capacity.
   5. Materials of construction and finishes provided.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each floor access door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area.
   1. Do not dump onto ground.

E. Protect floor access doors during shipment and storage to prevent warping, bending, and corrosion.

1.05 WARRANTY

A. Provide manufacturer’s warranty against defects in material and workmanship for a period of 5 years.

1.06 MAINTENANCE

A. Deliver 2 keys for each cylinder lock to Owner.

PART 2 PRODUCTS

2.01 LIGHT-DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Floor Doors Model K or KD (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDNA-SAL or BFDNA-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum live load of 150 pounds per square foot, and designed to open to 90 degrees and lock automatically in that position.

C. Door leaf: 1/4-inch aluminum diamond-pattern plate reinforced with aluminum stiffeners as required for specified live load.

D. Frame: 1/4-inch extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior.

E. Hardware:
   1. Hinges: Cast steel hinges bolted to underside door leaf that pivot on torsion bars that counterbalance door for ease of operation.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Automatic hold-open arm.

2.02 MEDIUM-DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model J or JD (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDDP-SAL or BFDDP-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum live load of 300 pounds per square foot, channel frame, with drainage couplings.

C. Door leaf: Minimum 1/4-inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged-brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.

3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
4. Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.

2.03 HEAVY-DUTY OFF-STREET FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model JH-20 or JDH-20 (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDDH-SAL or BFDDH-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum Standard Specifications for Highway Bridges, H-20 wheel load with a maximum deflection of 1/150 of the span, live load channel frame, with drainage couplings.

C. Door leaf: Minimum 1/4-inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged-brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
   5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.

2.04 HEAVY-DUTY IN-STREET ACCESS DOORS AND MANHOLE COVERS

A. As specified in Section 05500 - Metal Fabrications.

2.05 FALL PROTECTION GRATING SYSTEM

A. Furnish and install on vault access doors, where indicated on the Drawings, fall protection grating system.
   1. Door manufacturer shall install the grating system when the door is fabricated or field installed (by others) on existing doors already in use.
   2. If field installation is necessary grating system shall be installed per the manufacturer’s instructions.

B. Performance characteristics:
   1. Grating panel(s) shall be high visibility safety yellow in color.
   2. Grating panel(s) shall lock automatically in the full open position.
   3. Grating system shall have a 25 year warranty.

4. Grating panel(s) shall have a provision for locking to prevent unauthorized opening.

C. Grating: Panels shall be aluminum with a powder coat paint finish and designed to meet OSHA 29 CFR 1910 requirements for fall protection.

D. Hold open feature: A Type 316 stainless steel hold open device shall be provided to lock the cover in the fully open 90 degree position.

E. Hardware: All hardware shall be Type 316 stainless steel.

2.06 FINISHES

A. Floor access door finishes:
   1. Aluminum: Manufacturer's standard mill finish.
   2. Aluminum in contact with dissimilar metals and concrete: Manufacturer's standard bituminous coating.
   3. Steel: Manufacturer's standard red oxide primer.

B. Hardware finishes:
   1. Provide optional Type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive floor access door and verify correctness of dimensions and other supporting or adjoining conditions.

3.02 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring floor access doors.

B. Verify dimensions and profiles for each opening.

C. Verify that location will serve portion of work to which access is required.
   1. Where proposed functional location conflicts with other work, notify the Engineer before installation.

D. Apply coating to aluminum surfaces that will be in contact with dissimilar metals or concrete when there is none.

3.03 INSTALLATION

A. Install floor access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

D. Attach drainpipe to coupling provided.
   1. Unless noted or indicated on the Drawings, provide 1-inch PVC (Sch. 80) drain line for access door.
   2. Provide necessary fittings to connect and route at least 5 feet away from door and vault perimeter.
   3. Terminate drain line 1 foot below final grade with 3 cubic feet of drain rock beneath the termination point of the drain line.

3.04 ADJUSTING

A. Adjust doors, frames, and hardware to operate smoothly, freely, and properly without binding.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, or other impurities; touch up abraded prime coat where applicable.

END OF SECTION

SECTION 08332

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire rated insulated overhead coiling doors.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

B. ASTM International:
   1. A123 - Standard specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   3. A666 - Standard specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   4. A924 - Standard Specification for General Requirements of Steel Sheet, Metallic-Coated by the Hot-Dip Process (Referenced by ASTM A653).

1.03 SUBMITTALS

A. Product data:
   1. General: Submit data completely describing products, including rough-in diagrams.
   2. Electrical operators: Submit complete manufacturer's data for all components for electric door operators. Show motor size and characteristics. Show manufacturer's verification that motor has been adequately sized for each size and type of door required. Submit electrical schematic diagrams.

B. Shop drawings:
   1. Drawings showing complete installation details, required clearances, relation to building structure, complete electrical rough-in requirements required for installation of motor operators for doors and for connection of such doors to fire alarm system, referenced to the door mark number.
   2. Show location and size of access doors required to perform maintenance on doors and auxiliary equipment.

C. Samples: Submit samples of finishes for finish selection.

D. Quality control submittals:
   1. Manufacturer's instructions:
      a. Installation instructions for each type and size of door, including manufacturer's data, operating instructions, and maintenance data.

b. Furnish installer copy of diagrams and installation instructions.

E. Contract closeout submittals:
1. Project record documents:
a. Operation and maintenance data: Provide manufacturer's operation and maintenance data for each different type of door specified, complete with manufacturer's list of recommended spare parts and their prices, electrical schematic diagrams, and name and address of nearest maintenance organization approved by door manufacturer.
b. Warranty: Provide manufacturer's standard warranty.

1.04 QUALITY ASSURANCE

A. Regulatory requirements:
1. Wind loading as specified in Section 01850 - Design Criteria.
2. Seismic requirements for door anchorage and support systems as specified in Section 01850 - Design Criteria.
3. Provide electrical materials in NEMA Type enclosures as specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, and storage: Protect doors during shipment and storage to prevent warping, bending, and corrosion.

B. Deliver materials only after proper facilities are available: Provide clean dry surfaces or platform as required and protect from deterioration and foreign matter.

1.06 PROJECT CONDITIONS

A. Field measurements: Field verify all opening dimensions and clearances prior to fabricating doors. Fitting doors to openings is the responsibility of the Contractor.

1.07 SEQUENCING AND SCHEDULING

A. Inserts and anchorages: Furnish inserts and anchoring devices which must be set into concrete or built into masonry. Provide setting drawings, templates, and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay to the Contract.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design requirements:
1. Compatibility with space and service requirements:
a. Doors and equipment items provided shall be compatible with space limitations specified and indicated on the Drawings.
b. Make modifications to doors and equipment items necessary to conform with space limitations or with utility services specified for rough-in.

c. Provide items complete including all necessary ancillary equipment as may be required for complete and trouble-free operation.

2. Maintenance requirements: For ease of maintenance, provide overhead coiling doors complying with following requirements:
   a. Provide each door assembly as complete unit produced or supplied by a single manufacturer, including frames, sections, brackets, operating mechanisms, hardware, except hardware items specified in Section 08710 - Door Hardware, and all necessary accessories for installation of complete in openings indicated.
   b. Unless otherwise specified, all doors of particular type throughout the entire project shall be as manufactured or supplied by a single manufacturer.

2.02 MANUFACTURED UNITS

A. Manufacturers: One of the following or equal:
   1. Overhead Door Corp.
   2. Wayne-Dalton Corp.
   3. The Cookson Co., Inc.

B. Steel overhead coiling door:
   1. Mounting: Face of wall.
   2. Operation: As indicated on the Drawings.
   3. Curtain:
      a. Exterior slats: Manufacturer’s standard, minimum 20-gauge steel galvanized in accordance with ASTM A653, interlocking flat-faced slats with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
      b. Bottom bar: Steel galvanized in accordance with ASTM A123, fitted with 2 equal-sized steel angles minimum 1/8-inch thick, with lift handle and slide bolt at either end and provided with a flexible PVC bulb type astragal to ensure a consistent seal along the floor. Extrusion designed to interlock with door curtain.
      c. Weatherstripping:
         1) Bottom bar: Manufacturer's standard, provided with a flexible PVC bulb type astragal to ensure a consistent seal along the floor. Extrusion designed to interlock with door curtain.
         2) Door jambs: Manufacturer's standard vinyl extrusion seals, manufacturer's standard.
         3) Hood: Manufacturer's standard vinyl air baffle.
   4. Guides: Steel galvanized in accordance with ASTM A123, formed of roll formed steel channels and angles or structural angles of sufficient depth to provide a groove of adequate depth on each jamb to hold curtain firmly in guides under design wind pressure.
   5. Brackets: Steel galvanized in accordance with ASTM A123, steel plate with permanently sealed ball bearings designed to enclose ends of coil and provide support for counterbalance pipe at each end.
   6. Barrel and counterbalance mechanism: Steel pipe of sufficient size to carry door load with maximum deflection of 0.03 inch per foot of opening width and counterbalanced by helical springs, oil tempered torsion type designed with

minimum safety factor of 1.25 percent, and having cast iron barrel plugs that anchor springs to tension shaft and pipe.

7. Hood: Manufacturer's standard, minimum 24-gauge steel galvanized in accordance with ASTM A653, designed to enclose curtain coil and counterbalance mechanism.

C. Insulation:
   1. Interior slats: Material to match exterior slats as specified in previous article, interlocking flat-faced slats, manufacturer's standard size with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
   2. Insulation: CFC-free Polyethylene foam yielding a minimum R-value of 6.20.

D. Door operators:
   1. Push-up operator: Unless otherwise indicated on the Drawings, use at doors less than 56 square feet in area. Provide lift handles at the bottom bar.
   2. Chain operator: Unless otherwise indicated on the Drawings, use at doors 56 square feet or larger in area. Provide a continuous hand chain and gearing on coil side of door.
   3. Motor operator: Unless otherwise indicated on the Drawings, provide a heavy-duty type motor operator.
      a. High starting torque type motor having sufficient power to operate the load at an average speed of 1 foot per second.
      b. Totally enclosed, fan cooled, continuous-duty motor, sized to suit door size (1 horsepower minimum), with Class B insulation.
      c. 480 volt, 3-phase operation.
      d. Controlled by momentary contact 3-button station marked OPEN, CLOSE, and STOP. As indicated on the Drawings.
      e. Provide automatic screw-type limit switch to break circuit at termination of travel.
      f. Provide gear reducer consisting of high efficiency worm gearing running in an oil bath and a spring set, solenoid-operated brake designed to hold the load when power is off.
      g. Provide emergency hand chain operator which does not affect the time of the limit switch, to operate the load in case of power failure.
      h. Operator to have reversing NEMA Size 1 starter having mechanical and electrical interlocks, properly sized 24-volt control transformer, and other controls necessary for proper operation, completely assembled and wired to a terminal strip to facilitate field wiring of the power source, pushbutton stations, and/or other remote devices.
      i. Unless otherwise indicated on the Drawings, all electrical material supplied shall be in NEMA Type 12 enclosures for interior locations and in NEMA Type 4X enclosure or NEMA Type 4 enclosures for exterior or wet locations.
      j. Provide electronic safety edge to reverse direction of door if obstruction is encountered.
      k. Where no safety edge is specified, 2-button constant pressure type pushbutton stations marked OPEN and CLOSE shall be provided in lieu of 3-button station previously indicated.

2.03 ACCESSORIES

A. Fasteners: Sizes and types as recommend by reviewed door manufacturer.

2.04 FINISHES

A. Slats, hood and bottom bar:
   1. Galvanized steel: Manufacturer's standard rust inhibitive prime coat compatible with a topcoat finish paint system as specified in Section 09960 - High-Performance Coatings.

B. Guides and bracket plates:
   1. Galvanized steel: manufacturer's standard rust inhibitive prime coat in a flat black finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine openings to receive overhead coiling doors and verify:
   1. Dimensions and correctness of backing or support conditions.
   2. Absence of defects that would adversely affect installation.

B. Do not start the work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Verify dimensions and design for each opening.

B. Coordinate details with other work supporting or adjoining coiling doors.

C. Furnish fastening devices as required to mount doors properly.

3.03 INSTALLATION

A. Install doors in strict accordance with manufacturer's installation instructions, unless specifically otherwise indicated on the Drawings.

B. Install assemblies plumb, square, and level at their proper elevations and in their proper planes.

C. Securely anchor assemblies to interior face of openings, in manner that provides full opening clearance, perfectly aligned and adjusted for smooth operation.

D. Interface with other products: Separate or isolate dissimilar metals with neoprene gaskets, sleeves, or washers, or with an acceptable coating.

3.04 ADJUSTING

A. Verify that door assemblies are securely anchored to structure, guides are perfectly aligned, and doors are adjusted for smooth operation.

B. Upon completion of installation, ensure doors are free from warp, twist, or distortion and are lubricated and properly adjusted to operate freely.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, and other impurities.

B. Replace any damaged or otherwise disfigured doors with new prior to final acceptance.

3.06 DEMONSTRATION

A. Provide Owner's maintenance employees with minimum of 8 hours of maintenance instruction.

3.07 PROTECTION

A. Protect installed doors from damage until final acceptance.

END OF SECTION

SECTION 08412

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum entrance and storefront framing systems, including entrance door hardware and accessories.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. 45 - Designation System for Aluminum Finishes.

B. American Society of Civil Engineers (ASCE):
   1. SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

C. Architectural Aluminum Manufacturers Association (AAMA):
   1. 501 - Methods of test for Exterior Walls.
   2. 501.4 - Recommended Static Test Method for Evaluating Window Wall, Curtain Wall, and Storefront Systems Subjected to Seismic and Wind-Induced Inter-Story Drift.
   3. 501.5 - Test Method for Thermal Cycling of Exterior Walls.
   4. 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls, and Sloped Glazing Systems.
   5. 510.5 - Test Method for Thermal Cycling of Exterior Walls.
   6. 611 - Voluntary Specification for Anodized Architectural Aluminum.
   7. 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   3. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
   4. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   5. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   6. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
   7. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

E. International Code Council (ICC):
   1. A117.1 - Standard and Commentary: Accessible and Usable Buildings and Facilities.

1.03 SUBMITTALS

A. Product data: Include cleaning instructions and maintenance data.

B. Shop drawings: Include the following:
   1. Shop drawings must be prepared by a qualified engineering service under the employ of the window wall manufacturer and/or the installer.
      a. Detail fabrication and assembly of systems.
      b. Included design calculation.
   2. Storefront framing systems, glass and glazing, and details including components and attachments or junction with adjacent work.

C. Samples: Sufficient number of sections to show extremes of color range for each color selected.

D. Certificates of compliance: Include the following:
   1. Manufacturer's certificate, or certified test report from and accepted testing agency stating that entrance doors and storefront framing system meet or exceed performance requirements.
   2. Manufacturer's certificate stating that anodic finishes comply with requirements.

E. Quality assurance:
   1. Installer qualifications: Manufacture’s authorized representative who is trained and approved for installation of units required for this project.
   2. Engineering responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer’s standard units in systems similar to those indicated for this Project.
   3. Product options:
      a. Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assembles.
      b. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
      c. Performance characteristics are indicated by criteria subject to verification by 1 or more methods including preconstruction testing, field testing, and in-service performance.
         1) Do not change intended aesthetic effects, as judged solely by Architect/Engineer, except with Architect/Engineer’s approval. If changes are proposed, submit comprehensive explanatory data to Architect/Engineer for review.
   4. Accessible entrances: Comply with applicable provisions in the U.S Architectural & Transportation Barriers Compliance Board’s ADA-ABA Accessibility Guidelines and ICC A117.1.
   5. Source Limitations for Aluminum-Framed Systems; Obtain from single source from single manufacturer.

F. Manufacturer's Installation Instructions.

G. Pre-installation meetings:
   1. Conduct pre-installation meeting at project site minimum 30 days before beginning Work of this Section.
      a. Required participants:
         1) Contracting Officer’s Representative.
         2) Architect/Engineer.
         3) Contractor.
         4) Installer.
         5) Manufacturer’s field representative.
         6) Other installers responsible for adjacent and interesting work.

H. Pre-Submittal Conference:
   1. Conduct conference in compliance with requirements in Section 01312 - Project Meetings with attendance by representatives of Supplier, Installer, and Contractor.
      a. Contractor to review proper methods and procedures for installing hollow metal doors and frames.

1.04 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

B. Special warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
   1. Warranty duration: 2 years.

C. Special finish warranty: Manufacturer’s standard form in which manufacturer agrees to repair or replace components on which finished do not comply with requirements or that fail in material or workmanship within specified warranty period. Warranty does not include normal weathering.
   1. Warranty duration: 10 years.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver entrances and storefront units and components marked with type and location of installation.

B. Protect aluminum from damage with protective sleeves, polyethylene sheets, removable coatings, or other suitable means.
   1. Protect prefinished aluminum surfaces with strippable coating.

C. Deliver products when proper facilities are available.

D. Ship and store products in manner that prevents damage such as warping, bending, stains, discolorations, scratches, abrasions, or soiling.

E. Remove protective devices only when required to perform work or in absence of damage-producing conditions prior to final acceptance.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Comply with the requirements of the building code specified in Section 01410 - Regulatory Requirements.

B. Delegated design:
   1. Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.
   2. Minor deviations to details indicated on the Drawings to accommodate manufacturer's standard products may be accepted by the Engineer when deviations do not affect design concept and specified performance.

C. Air leakage:
   1. Test in accordance with ASTM E283.
   2.
   3. Storefront:
      a. Test load: Static air pressure differential of 6.24 pounds per square foot.
      b. Performance criteria: Maximum leakage of 0.06 cubic feet per minute.

D. Water penetration resistance - storefront:
   1. Test in accordance with ASTM E331.
   2. Test load: Minimum static air pressure differential of 8 pounds per square foot.
   3. Performance criteria: No water penetration at test pressure.

E. Uniform load tests - deflection of storefront:
   1. Wind load:
      a. Test in accordance with ASTM E330, Procedure A ("load-deflection curve not required").
      b. Test load: Not less than the wind pressure specified for "Components and Cladding - Walls" in Section 01850 - Design Criteria.
      c. Proof load: Not less than 1.5 times the test load.
      d. Performance criteria:
         1) Deflection of any framing member: Not exceeding L/175 (0.57 percent) of the span of that member.
         2) Permanent set in framing members after proof loads: Not exceeding L/500 (0.20 percent) of the span of that member.
         3) No glass breakage.
         4) No damage to fasteners or hardware.
   2. Seismic requirements:
      a. Aluminum-Framed entrances and storefronts shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7, acceleration criteria specified in Section 01850 - Design Criteria.

b. Design displacement:
    1) Providing design displacements not less than the following when tested in accordance with AAMA 501.4:
        a) Elastic displacement: Not less than 10 percent of the story height.
        b) Ultimate (inelastic) displacement: Not less than 1.5 times the design displacement at the story.

F. Average thermal conductance: Provide storefront systems with average U-values of not more than 0.63 Btu per square foot by height by degrees Fahrenheit when tested in accordance with AAMA 1503.

G. Condensation Resistance Factor (CRF): When tested to AAMA Specification 1503, the condensation resistance shall not be less than 45.

2.02 ENTRANCE DOORS

A. Manufacturers: One of the following or equal:
    1. Arcadia Inc. Products.
    2. OldCastle Building Envelope.

B. Aluminum framing material:
    1. Sheet metal: ASTM B209, minimum 1.6 millimeters (0.063 inch) thick.
    2. Extrusions: Extruded 6063- T6 allow and temper in accordance with ASTM B221.
        a. Framing: Minimum 0.100 wall thickness.
        b. Glazing beads, moldings, and trim: minimum 1.25 millimeters (0.050 inch) thick.
    3. Extruded bars, rods, profiles, and tubes: ASTM B221.
    4. Extruded structural pipe and tubes.
    5. Thermal break: Manufacturer standard low conductive material retarding heat flow in the framework, where insulating glass is scheduled.

C. Stile and rail face dimensions:
    1. Vertical stiles: Maximum 3-1/2 inches.
    2. Top rail: Maximum 2-1/4 inches.
    3. Bottom rail: Minimum 10 inches.

D. Bottom rail of door: Manufacturer's standard channel section which closes bottom of door.

E. Glass:
    1. Tinted monolithic, tempered, 1/4 inches thick, as specified in Section 08800 - Glazing.

F. Glazing gaskets: EPDM elastomeric extrusions, manufacturer's standard sizes and shapes.

G. Glazing moldings: Minimum 0.050-inch thick, hook-in type.

H. Fasteners:
   1. Exposed fasteners: Aluminum, stainless steel or plated steel in accordance with ASTM B633.
   2. Perimeter anchors: Aluminum or steel.

2.03 STOREFRONT

A. Manufacturers: One of the following or equal:
   1. Arcadia Inc. AG451T.
   2. Kawneer Co., Trifab VG 451T.
   3. OldCastle Building Envelope, equivalent product.

B. Aluminum framing material:
   1. Sheet metal; ASTM B209, minimum 1.6mm (0.063 inch) thick.
   2. Extrusions: Extruded 6063- T6 allow and temper in accordance with ASTM B221.
      a. Framing: Minimum 0.125 inch wall thickness.
      b. Glazing beads, moldings, and trim: minimum 1.25mm (0.050 inch) thick
   3. Extruded bars, rods, profiles, and tubes: ASTM B221.
   4. Extruded structural pipe and tubes.

C. Extruded 6063-T6 allow and temper in accordance with ASTM B221 alloy G.S. 10A-T6, minimum 0.125 inches thick.

D. Dimensions: 2-inch face by 4-1/2 inch overall depth.

E. Glazing provisions: Center glazed in minimum 1-inch deep by 1-5/16 wide pockets, able to conceal insulating glass spacers, for flush glazing without projecting stops, capable of being inside glazed.

F. Glazing gaskets: EPDM elastomeric extrusions, manufacturer's standard sizes and shapes.

G. Glass: Insulating, as specified in Section 08800 - Glazing.

H. Adapters and mountings for trim moldings and face materials: Capable of installation without interfering with normal assembly and weathering of storefront.

I. Steel reinforcing: ASTM A36.

J. Flashings: Minimum 0.63-inch thick aluminum sheet.

K. Closures: Minimum 0.125-inch thick aluminum sheet.

L. Fasteners:
   1. Exposed fasteners: Aluminum, stainless steel or plated steel in accordance with ASTM B633.
   2. Perimeter anchors: Aluminum or steel.

M. Anchorage and alignment brackets: Capable of concealed support of storefront from building structure.

N. Coating to isolate dissimilar metals: Bituminous paint, minimum 2 coats having minimum total thickness of 5 mils.

O. Coating to isolate aluminum from concrete, wood or other absorptive material: Zinc chromate metal primer, minimum 2 coats having minimum thickness of 3 mils.

P. Sealants: As specified in Section 07900 - Joint Sealants.

2.04 FABRICATION

A. Extrude sections true to details with clean, straight, sharply defined profiles, smooth surfaces of uniform texture, and free from defects impairing strength and durability.

B. Accurately mill and fit sections to provide flush hairline joints.

C. Execute cutting, fitting, forming, drilling, and grinding of metalwork prior to cleaning, finishing, treatment, and application of coatings.

D. Maintain continuity of line and accurate relations of planes and angles.

E. Securely attach and support mechanical joints with hairline fit of contacting members.

F. Install stiffeners to reinforce framing when necessary to meet performance requirements.

G. Separate dissimilar metals with bituminous paint or preformed separators which will prevent corrosion.

H. Separate metal surfaces at moving joints with nonmetallic separators to prevent freeze-up of joints.

I. Fabricate frame assemblies for exterior walls with flashing and weeps to drain penetrating moisture to exterior.

J. Allow for thermal expansion of exterior units.

K. Accurately make cutouts, recesses, mortising or milling, and reinforce doors for hardware.

L. Weld door joints along concealed lines of contact to prevent pitting, halo, and other imperfections after finishing.
   1. Thoroughly penetrate material with welds to produce complete fusion of metal between stiles and rails.
   2. Door corner construction to have manufacturer’s limited lifetime warranty.

M. Mechanically join door sections with interlocking aluminum channel clips and flat head stainless steel screws.

N. Both mechanically clip fasten and weld door corners by manufacturer's standard methods.

O. Drill, tap, cut out, and reinforce frames and doors for mortise hardware and surface mounted hardware in accordance with templates supplied by hardware manufacturers.

P. Make total thickness of reinforcement equal to nominal diameter of hardware fasteners.

2.05 FINISHING

A. Exposed aluminum surfaces: Anodized in accordance with AA 45 Architectural Class 1, Anodic Coating AA-M12C22A42/44; without gripper marks on exposed surfaces; with uniform color from exposed faces onto exposed edges, dark bronze color.

B. Concealed aluminum surfaces: Same as exposed aluminum surfaces or anodized in accordance with AA 45 Architectural Class 2, Anodic Coating AA-M12C22A31, clear.

C. Exposed fasteners: Match adjacent material in color and appearance or 300 series stainless steel heat-tempered to match color of anodized surface.

D. Concealed steel fasteners:
   1. In contact with aluminum: Stainless steel, 300 Series.
   2. Not in contact with aluminum: Structural or mild steel hot-dip galvanized after fabrication and touched-up when welded.

E. Steel: Mill scale and rust cleaned or ground off, grease and dirt cleaned off, chemically etched and 1 prime coat applied.

2.06 MARKING UNITS AND COMPONENTS

A. Mark entrances and storefront units and components with type and location of installation.
   1. Mark without damaging surfaces.
   2. Use designations indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify wall openings and adjoining work are ready to receive work of this Section.

B. Examine receiving frames and reviewed hardware schedules to verify coordination with doors.

3.02 INSTALLATION OF STOREFRONT

A. Install aluminum storefront systems in accordance with manufacturer's instructions and Engineer accepted shop drawings.

B. Separate or isolate dissimilar metals and materials with coatings prior to installation.

C. Set plumb, square, level, and in alignment with other work.

D. Use anchorage devices to securely attach framing assembly to structure.

E. Align assemblies plumb and level, free of warp or twist.
   1. Maintain assemblies' dimensional tolerances, aligning with adjacent work.

F. Install watertight flashings.
   1. Set sill members in double bead of sealant.

G. Lead collected moisture or water to outside as directly as possible.

H. Seal joints between framing and building structure as specified in Section 07900 - Joint Sealants.

3.03 ADJUSTING

A. After completion of glazing and finish painting, adjust doors and door hardware as required for smooth operation and correct function.

B. Lubricate hardware and moving parts.

3.04 CLEANING

A. Remove protective material from prefinished aluminum surfaces just before inspection for final acceptance.

B. Clean in accordance with recommendations of AA and manufacturer's cleaning instructions using only materials approved by aluminum manufacturer.
   1. Where doubt exists, make spot tests.

C. Remove soil or other sources of discoloration.

END OF SECTION

SECTION 08518

FIRE RATED WINDOWS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pre-painted fire rated aluminum clad steel windows.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
   2. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under specified Pressure Differences Across the Specimen.
   3. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static air Pressure Difference.
   4. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

B. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Product data: Include joinery, finishes, thickness of materials, and glazing materials.

B. Shop drawings: Include floor plans, elevations, location and spacing of anchorage, sizes, and relationship to adjoining construction.

C. Samples: Include glazing materials, finishes and colors.

D. Erection instructions.

1.04 REGULATORY REQUIREMENTS

A. Windows shall meet requirements and bear UL or WHI label for fire rating indicated.

1.05 COORDINATION

A. Where anchorage involves other construction, provide setting drawings for proper installation.

1.06 WARRANTY

A. Warrant to repair or replace defective materials with acceptable materials for minimum 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Fire rated windows:
   1. The following or equal:
      a. O'Keeffe's, Inc., GPX UL 439, Glassprotex Fire Windows.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Structural: Sections able to withstand minimum wind load pressure prescribed by governing building code with maximum deflection of l/180 horizontally and l/360 vertically of span on members when tested in accordance with ASTM E330 with safety factor of 1.65.

B. Air infiltration: Maximum 0.06 cubic feet per minute per square foot of fixed area when tested in accordance with ASTM E283.

C. Water infiltration: No water penetration at test pressure of 20 percent of design load when tested in accordance with ASTM E331.

2.03 MATERIALS

A. Aluminum cladding: Extruded allow 6063-T5 of sufficient thickness for application.

B. Steel: ASTM A501, steel tubing.

C. Glass with 30 or 60-minute rating: Composed of 2 lites of tempered glass separated by metal spacer and space filled with clear, transparent, distortion-free gel capable of absorbing heat radiation.

D. Glass with 90-minute rating: Composed of 3 lites of tempered glass separated by metal spacers and spaces filled with clear, transparent, distortion-free gel capable of absorbing heat radiation.

E. Glazing tape: Ceramic fiber tape capable of withstanding maximum temperatures.

2.04 RELATED MATERIALS

A. Sealant: Silicone as recommended by manufacturer.

B. Paint: Duranar fluoropolymer, color as selected:
   1. Manufacturers: The following or equal:
      a. PPG Industries.

2.05 FABRICATION

A. Install aluminum cladding without visible fasteners.

B. Factory fabricate and pre-assemble framing system in largest size consistent with economic considerations for shipping and handling.

C. Fit and fasten joints with no visible gaps and fasteners.

2.06 FINISH

A. Chemically clean and pretreat aluminum surfaces with chromatic chemical conversion coating, such as Alodine® using minimum 3-coat system.

B. Paint exposed metal surfaces with 2-coat system.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify compliance of substrate and members to which system attaches or adjoins with manufacturer's instructions.

3.02 INSTALLATION

A. Install system in accordance with manufacturer's instructions.

B. Erect members square, plumb, in true alignment with one another, and with adjacent work.
   1. Leave surfaces free from dents, buckles, dimples, or other defects.
   2. Secure fastening anchors in accordance with required safety factors.

3.03 CLEANING

A. Clean glass, framing system, and accessories.

B. Leave glazing panels in clear, scratch-free condition inside and out.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fixed aluminum windows with hardware.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. 45 - Designation System for Aluminum Finishes.
   2. 92 - Care of Aluminum.

B. American Architectural Manufacturer's Association (AAMA):
   1. GS-001 - Aluminum Architectural Windows.
   2. 101 - North American Fenestration Standard/Specification for Windows, Doors, and skylights.

C. ASTM International (ASTM):
   1. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   2. C509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   3. C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   4. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.
   5. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
   6. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   7. E547 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   8. F588 - Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Include dimensioned elevations of window openings and sash sizes, complete framing details, glass and glazing details, hardware, and anchorage details to adjacent structure.

C. Samples: Minimum 12 inches in length, illustrating, factory-applied aluminum finishes.

D. Manufacturer's Installation Instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identification: Prior to shipping identify each window with type location of each window, using Engineer's window mark, in manner as not to damage surface.

B. Packing: Provide wrapping or strippable coating to protect prefinished aluminum surfaces.

C. Delivery: Delivery materials only after proper facilities are available.

D. Shipping, storage, and protection: Ship and store materials in manner that prevents damage such as warping, bending, stains, discolorations, scratches, abrasions, or soiling.

1.05 PROJECT CONDITIONS

A. Protect aluminum from damage using protective sleeves, polyethylene sheets, removable coatings, or other suitable means.

B. Remove protective devices only when required to perform work or in absence of damage-producing conditions prior to final acceptance.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Comply with the requirements of the building code specified in Section 01410 - Regulatory Requirements.

B. Comply with testing and performance requirements of AAMA AAMA 101 for the Performance Class and Performance Grade specified.
   1. Design Pressure (Performance Grade):
      a. Not less than the wind load specified for "Components and Cladding - Walls" in Section 01850 - Design Criteria.
         1) Use allowable stress design (ASD) wind pressure.
         2) If specified wind pressure is not a multiple of 5 pounds per square foot, round upward to the next 5 pounds per square foot.
   2. Air leakage test:
      a. Test in accordance with ASTM E283.
      b. Test load: Minimum 6.24 pounds per square foot acting inward.
      c. Performance criteria: Maximum 0.37 cubic feet per minute per foot of operable sash crack length or 0.15 cubic feet per minute per square foot of fixed window area.
   3. Water penetration resistance test:
      a. Test in accordance with ASTM E547.

b. Test load: Not less than 15 percent of the specified design pressure.
c. Performance criteria: No water infiltration at fixed or ventilator lights when tested at static air test load.

4. Uniform load tests - deflection:
   a. Test in accordance with ASTM E330 - Procedure A (load-deflection curve not required.)
   b. Test load: Not less than the specified design pressure.
   c. Proof load: Not less than 1.5 times the test load.
   d. Performance criteria: When tested with ventilators closed and locked, and with air pressure applied first to one side and then to the other, deflection not greater than 1/175 of the clear span length (L/175).
5. Uniform load tests - structural performance:
   a. No glass breakage, permanent damage to fasteners, hardware parts, support arms, or actuating mechanism, and damage that would cause the unit to be inoperable when tested in accordance with ASTM E330 at static air pressure difference of 6.24 pounds per square foot with pressure applied first on one side and then other side.

C. Window component structural performance: In compliance with performance requirements indicated by and when tested in accordance with AAMA GS 001.

D. Forced entry resistance: Minimum Performance Level 10 when tested in accordance with ASTM F588.

2.02 ALUMINUM WINDOWS

A. AAMA 101:
1. CW-PG40-FW - fixed window.
2. Manufactures: One of the following or equal:
   a. Kawneer Co., Sealair Model 8225T Isolock.
   b. Hope Architectural Products, Model 210T Series.

B. Extrusions: 6063-T5 alloy and temper in accordance with ASTM B221 Alloy G.S. 10A-T5.

C. Glass: Insulating glass, as specified in Section 08800 - Glazing.

D. Glazing: Compatible with aluminum, sealants, and sealing materials and compatible with gasketing material:
1. Exterior windows: Dry glazed closed cell elastomeric material in accordance with ASTM C509, manufacturer's standard size and shape.
2. Interior windows: ASTM C864, aluminum glazing bead, snap-in type and compression wedge of dense elastomer.

E. Screens: 18 by 16 aluminum mesh screen cloth, secured in extruded aluminum frames, rigidly joined at corners, with removable extruded vinyl splines capable of permitting re-screening.

2.03 FABRICATION

A. Window framing and vent members: One part framing members with 3/8-inch thermal barrier, 2-1/4-inch overall depth, minimum 0.125-inch thick extrusions.

B. Thermal barrier: 2-part, chemically cured, high-density polyurethane.

C. Ventilator corner attachment: Permanently leakproof; mitered, clipped, epoxied, and staked; or mitered, clipped, and sigma arc welded.

D. Frame corners and meeting rail intersection attachments: Permanently leakproof; coped and tenoned, and forged; or mortised and tenoned, and sigma arc welded.

E. Weep slots: Capable of positive drainage to exterior and protected by snap-in-weep covers or integral drips.

F. Glazing beads: 0.050 inch thick.

G. Glazing rabbets: Minimum 13/16 inch deep by width required for glass.

H. Glazing method: Outside.

I. Finishes:
   1. Exposed aluminum: Anodize exposed aluminum surfaces uniformly in accordance with AA 45, Architectural Class 1 Anodic Coating AA-M12C22A42/44, without gripper marks, dark bronze color.
   2. Concealed aluminum: Same as exposed aluminum surfaces or clear anodized in accordance with Architectural Class II Clear Anodic Coating AA 45 AAM12C22A31.
   3. Steel: Mill scale and rust cleaned or ground off, grease and dirt cleaned off, chemically etched and 1 prime coat applied.

2.04 RELATED MATERIALS

A. Exposed fasteners: Type 305 stainless steel, manufacturer's standard.

B. Concealed fasteners: Manufacturer's standard steel with provisions to isolate dissimilar metals, or aluminum:
   1. Steel in contact with aluminum: Cadmium plated or Type 305 stainless steel.
   2. Steel not in contact with aluminum: Structural or mild steel hot-dip galvanized after fabrication and touched-up when welded.

C. Coatings for isolating dissimilar metals: Manufacturer's standard bituminous paint.

D. Coatings for isolating aluminum from concrete, metal, wood, or other absorptive material: Manufacturer's standard zinc chromate metal primer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify wall openings and adjoining work are ready to receive aluminum windows.

B. Examine receiving frames and reviewed hardware schedules to verify coordination with doors.

3.02 INSTALLATION

A. Install aluminum windows in accordance with manufacturer's instructions.

B. Set plumb, square, level, and in exact alignment with other work.

C. Anchor frames to structure securely.

D. Align assemblies plumb and level, free of warp or twist. Maintain assemblies dimensional tolerances, aligning with adjacent work.

E. Coordinate attachment and seal of air and vapor barrier materials. Install under sill flashings.

F. Pack fibrous insulation in shim spaces at perimeter to maintain continuity of thermal barrier.

G. Install watertight flashings.

H. Lead collected moisture or water to outside as directly as possible.

I. Seal joints between framing and building structure in manner to provide watertight installation as specified in Section 07900 - Joint Sealants.

J. Separate or isolate dissimilar metals and materials with coatings:
   1. Apply minimum 2 coats to obtain minimum thickness of 5 mils to isolate dissimilar metals.
   2. Apply minimum 2 coats to obtain minimum thickness of 3 mils to isolate aluminum from concrete, metal, wood or other absorptive material.

K. Install screens and frames at operable units.

3.03 ADJUSTING

A. After completion of glazing and finish painting, adjust windows and window hardware as required for smooth operation and correct function, and lubricate hardware and moving parts as required.

B. Adjust operable units for smooth, free, and easy operation without binding.

3.04 CLEANING

A. Remove protective material from prefinished aluminum surfaces.

B. Clean in accordance with recommendations of AA 92 and reviewed manufacturer's cleaning instructions using only materials approved by aluminum manufacturer. Where doubt exists, make spot tests.

C. Remove soil or other sources of discoloration.

END OF SECTION

SECTION 08620

UNIT SKYLIGHTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Manufactured curb mounted acrylic glazed domed skylights.

1.02 REFERENCES

A. California Occupational Safety and Health Administration (Cal/OSHA):
   1. Section 3212 - Floor Openings, Floor Holes, Skylights and Roofs.

1.03 SUBMITTALS

A. Product data:
   1. Shop drawings indicating size and materials.
   2. Indicate on shop drawings compliance with Cal/OSHA Section 3212 Floor Openings, Floor Holes, Skylights and Roofs.

B. Samples: Include metal finishes and colors of metal framed skylights.

C. Manufacturer's installation instructions.

D. Warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

1.05 WARRANTY

A. Skylight Warranty: Provide written warranty signed by manufacturer, agreeing to repair or replace work that exhibits defects in materials or workmanship and guaranteeing weather-tight and leak-free performance. “Defects” is defined as uncontrolled leakage of water and abnormal aging or deterioration.
   1. Warranty Period: 5 years from date of Substantial Completion.

B. Plastic Warranty: Provide written warranty signed by manufacturer agreeing to repair or replace work that has or develops defects in the plastic. “Defects” is defined as abnormal aging or deterioration.
   1. Warranty Period for Glazing: 5 years from date of Substantial

C. Finish Warranty: Provide written warranty signed by manufacturer agreeing to repair or replace work with finish defects. “Defects” is defined as peeling, chipping, chalking, fading, abnormal aging or deterioration, and failure to perform as required.
   1. Warranty Period for Kynar 500 Finish: 5 years from date of Substantial Completion (10 and 20 years available if specified).

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Design loads:
   1. Wind, snow, seismic, and dead load in accordance with the building code as specified in Section 01410 - Regulatory Requirements.
   2. Live loads:
      a. Uniform live load indicated on the roof plan.

B. Skylight screens in accordance with Cal/OSHA Section 3212.
   1. Maximum loading: 400 pounds.

2.02 SKYLIGHTS

A. Unit skylights:
   1. Manufacturers: The following or equal:
      a. Wasco Products, Inc.
      b. Solatube

2.03 PLASTIC UNIT SKYLIGHTS

A. Components:
   1. Domes: Double dome, impact resistant, acrylic glazed.
   2. Dome color: White.
   3. Frame: Mil finished aluminum, thermally broken.
   4. Gaskets: Neoprene.
   5. Mounting: Prefabricated curb as provided by manufacturer, minimum 16-inches in height.

B. Size: As indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install skylights in accordance with manufacturer's recommendations.

B. Install fall protection: In accordance with Cal/OSHA Section 3212 Floor Openings, Floor Holes, Skylights and Roofs.

C. Isolate aluminum from dissimilar metals and cementitious materials to prevent corrosion with gaskets.

D. Coordinate installation of skylights and roofing membrane to ensure weathertight installation.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Door hardware.

1.02 REFERENCES

A. Builders Hardware Manufacturers Association (BHMA):
   1. A156.1 - Butts and Hinges.156.2 - Bored and Preassembled Locks and Latches.
   2. A156.3 - Exit Devices.
   3. A156.4 - Door Controls.
   4. A156.13 - Mortise Locks and Latches.
   5. A156.14 - Sliding and Folding Door Hardware.
   6. A156.16 - Auxiliary Hardware.
   7. A156.18 - Materials and Finishes.
   8. A156.23 - Electromagnetic Locks.
   9. A156.26 - Continuous Hinges.
   10. A156.31 - Electric Strikes and Frame Mounted Actuators.
   11. A156.36 - Auxiliary Locks.

B. International Building Code (ICC):
   1. A117.1 - Accessible and Usable Buildings and Facilities.

C. National Fire Protection Association (NFPA):
   1. 80 - Fire Doors and Windows.
   2. 105 - Installation of Smoke Door Assemblies.
   3. 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories, Inc. (UL):
   1. 10C - Positive Pressure Fire Tests of Door Assemblies.
   2. 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.

1.03 SUBMITTALS

A. Product data:
   1. Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
   2. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

B. Hardware schedule:
   1. Include references to Engineer's hardware group number, door type designations, locations, other pertinent data, and manufacturer names or suitable abbreviation opposite items scheduled.
   2. Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
      b. Organization:
         1) Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
         2) Organize door hardware sets in same order as in the Door Hardware Sets at the end of this Section.
         3) Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
      c. Content: Include the following information:
         1) Type, style, function, size, label, hand, and finish of each door hardware item.
         2) Manufacturer of each item.
         3) Fastenings and other pertinent information.
         4) Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
         5) Explanation of abbreviations, symbols, and codes contained in schedule.
         6) Mounting locations for door hardware.
         7) Door and frame sizes and materials.
         8) Warranty information for each product.
      d. Submittal Sequence:
         1) Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule.
         2) Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying schedule:
   1. After a keying meeting with the owner has taken place prepare a separate keying schedule detailing the final instructions.
   2. Submit the keying schedule in electronic format.
   3. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions.
   4. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

D. Keying schedule: Include list giving key code and numbers of doors which can be opened by each key.

E. Samples: Include for each different type and manufacturer for review of finish.

F. Construction key distribution list: Submit upon Owner's request.

G. Templates:
   1. Furnish hardware templates to fabricators of doors, frames, and other work to be factory-prepared for hardware.
   2. Check shop drawings of other work to confirm that adequate hardware backing is available.

H. Project record documents: Include corrected hardware schedule.

I. Operating and Maintenance Manuals:
   1. Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation.
   2. As specified in Section 01782 - Operation and Maintenance Manuals.

1.04 REGULATORY REQUIREMENTS

A. Provide hardware for fire-resistive rated openings that complies with UL and listed by UL.

B. Provide State Fire Marshall approved fire-rated cross-corridor assemblies and panic devices.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver hardware where directed in unopened packages with items packed separately, complete and ready for installation with necessary fittings, trim, fasteners, and accessories.

B. Provide packages bearing the manufacturers' labels with each item or group of items identified according to the accepted hardware schedule.

1.06 QUALITY ASSURANCE

A. Certified products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

B. Installer qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door hardware supplier qualifications:
   1. Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project.

2. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity.
3. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Pre-submittal conference:
1. Conduct coordination conference in compliance with requirements in Section 01312 - Project Meetings with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
2. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products.
3. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
4. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
5. Review sequence of operation narratives for each unique access controlled opening.
6. Review and finalize construction schedule and verify availability of materials.
7. Review the required inspecting, testing, commissioning, and demonstration procedures.

1.07 MAINTENANCE

A. Require lockset manufacturers to deliver permanent removable cylinder cores and keys and minimum 2 extractor keys to Owner directly.

1.08 SCHEDULING AND SEQUENCING

A. Upon receipt of accepted hardware schedule, coordinate accepted hardware schedule, templates, reinforcing units, and template instructions to door and frame sections.

B. Restrict distribution of construction keys to superintendents and foremen. Maintain record of persons who have received keys on construction distribution list.

1.09 MAINTENANCE TOOLS AND INSTRUCTIONS

A. Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

1.10 WARRANTY

A. Provide warranty as specified in Section 01783 - Warranties and Bonds.
   1. Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
      a. Structural failures including excessive deflection, cracking, or breakage.
      b. Faulty operation of the hardware.
      c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      d. Electrical component defects and failures within the system’s operation.

B. Special warranty:
   1. Duration for electromechanical door hardware: 2 years.
   2. Duration for standard duty cylindrical (bored) locks and latches: 5 years.
   3. Duration for exit hardware: 5 years.
   4. Duration for mortise locks and latches: 10 years.
   5. Duration for manual overhead door closer bodies: 10 years.
   6. Duration for heavy duty floor closers: 10 years.

PART 2 PRODUCTS

2.01 GENERAL

A. Door hardware includes, but is not necessarily limited to, the following:
   1. Mechanical door hardware.
   2. Electromechanical door hardware.
   3. Automatic operators.
   4. Cylinders.

2.02 FASTENERS

A. Types:
   1. To concrete, marble, or masonry: Machine screws and flush shells.
   2. To wood: Wood screws.
   3. On gypsum board or plaster: Screws of sufficient length to provide solid connection to framing or backing behind gypsum board or plaster.
   4. To mineral and hollow core doors: Hex bolts.
   5. Of exit devices to doors: Thru-bolts, unless otherwise specified.

B. Screws exposed: Phillips-head type, full-threaded screws, not combination type.

C. Sizes: Suitable for heavy use.

D. Finish: Stainless steel, unless otherwise required to match material and hardware finish.

2.03 HANGING DEVICES

A. Hinges: BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
   1. Quantity: Provide the following hinge quantity:
      a. 2 Hinges: For doors with heights up to 60 inches.
      b. 3 Hinges: For doors with heights 61 to 90 inches.
      c. 4 Hinges: For doors with heights 91 to 120 inches.
      d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
      e. Hinge size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
         1) Widths up to 3 feet 0 inches: 4-1/2 inches standard or heavy weight as specified.
         2) Sizes from 3 feet 1inch to 4 feet 0 inched: 5inches standard or heavy weight as specified.
      f. Hinge weight and base material: Unless otherwise indicated, provide the following:
         1) Exterior doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
         2) Interior doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
      g. Hinge options: Comply with the following:
         1) Non-removable pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
      h. Manufacturers: One of the following or equal:
         1) Hager Companies (HA).
         2) Ives (IV).
         3) McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
      i. Electric door wire harnesses:
         1) Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to 12 wires.
         2) Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware.
         3) Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening.
         4) Wire nut connections are not acceptable.
         5) Determine the length required for each electrified hardware component for the door type, size and construction, minimum of 2 per electrified opening.
         6) Manufacturers: One of the following or equal:
            a) Hager Companies (HA) - Quick Connect.

b) McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC-C Series.
c) Stanley Hardware (ST) - WH Series.

2.04 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body. Lock systems are to be compatible with Best Access System locks.
   1. Manufacturers: One of the following or equal:
      a. Corbin Russwin Hardware (RU) - ML2000 Series.
      b. Sargent Manufacturing (SA) - 8200 Series.
      c. Schlage (SC) - L9000 Series.

B. Cylindrical Locksets, Grade 1 (Heavy Duty): BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed. Lock systems are to be compatible with Best Access System locks.
   1. Furnish with solid cast levers, standard 2-3/4 inch backset, and 1/2 inch (3/4 inch at rated paired openings) throw brass or stainless steel latch bolt.
   2. Locks are to be non-handed and fully field reversible.
   3. Manufacturers: One of the following or equal:
      a. Corbin Russwin Hardware (RU) - CL3300 Series.
      b. Sargent Manufacturing (SA) - 10 Line.
      c. Schlage (SC) - ND Series.

2.05 ELECTROMECHANICAL LOCKING DEVICES

A. Electromechanical Mortise locksets, Grade 1 (heavy duty): Subject to same compliance standards and requirements as mechanical mortise locksets, electrified locksets to be of type and design as specified below.
   1. Electrified Lock Options:
      a. Where indicated in the Hardware Sets, provide electrified options including: Outside door lock/unlock trim control, latch bolt and lock/unlock status monitoring, deadbolt monitoring, and request-to-exit signaling.
      b. Support end-of-line resistors contained within the lock case.
      c. Unless otherwise indicated, provide electrified locksets standard as fail secure.
   2. Energy efficient design:
      a. Provide lock bodies which have a holding current draw of 15mA maximum and can operate on either 12 or 24 volts.
      b. Locks are to be field configurable for fail safe or fail secure operation.
   3. Manufacturers: One of the following or equal:
      a. Corbin Russwin Hardware (RU) - ML20900 Series.
      b. Sargent Manufacturing (SA) - 8200 Series.
      c. Schlage (SC) - L9000 EL/EU/RX Series.

B. Electromechanical cylindrical locksets, Grade 1 (heavy duty): Subject to same compliance standards and requirements as mechanical cylindrical locksets, electrified locksets to be of type and design as specified below.
   1. Electrified lock options:
      a. Where indicated in the Hardware Sets, provide electrified options including: Outside door lock/unlock trim control and request-to-exit signaling.
      b. Unless otherwise indicated, provide electrified locksets standard as fail secure.
   2. Manufacturers: One of the following or equal:
      a. Corbin Russwin Hardware (RU) - CL33900 Series.
      b. Sargent Manufacturing (SA) - 10G70/71 Series.
      c. Schlage (SC) - ND DEL/DEU Series.

2.06 AUXILIARY LOCKS

A. Mortise deadlocks, small case:
   1. BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel.
   2. Steel or stainless steel bolts with a 1 inch throw and hardened steel roller pins.
   3. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.
      a. Manufacturers: One of the following or equal:
         1) Corbin Russwin Hardware (RU) - DL4100 Series.
         2) Sargent Manufacturing (SA) - 4870 Series.
         3) Schlage (SC) - L460 Series.

B. Cylindrical deadlocks:
   1. BHMA A156.36, Grade 1, cylindrical type deadlocks to fit standard ANSI 161 preparation and 1-3/8 inch to 1-3/4 inch thickness doors.
   2. Provide tapered collars to resist vandalism and 1 inch throw solid steel bolt with hardened steel roller pins.
   3. Deadlocks to be products of the same source manufacturer and keyway as other locksets.
      a. Manufacturers: One of the following or equal:
         1) Corbin Russwin Hardware (RU) - DL3200 Series.
         2) Sargent Manufacturing (SA) - 480 Series.
         3) Schlage (SC) - B600 Series.

2.07 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
   1. Flat-lip strikes: For locks with 3-piece antifriction latch-bolts, as recommended by manufacturer.
   2. Extra-long-lip strikes: For locks used on frames with applied wood casing trim.
   3. Aluminum-frame strike box: Provide manufacturer's special strike box fabricated for aluminum framing.
   4. Double-lipped strikes:
      a. For locks at double acting doors.

b. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.08 ELECTRIC STRIKES

A. Standard electric strikes:
1. Electric strikes tested to BHMA A156.31, Grade 1, for use on non-rated or fire rated openings.
a. Strikes shall be of stainless steel construction tested to a minimum of 1,500 pounds of static strength and 70 foot-pounds of dynamic strength with a minimum endurance of 1 million operating cycles.
b. Provide strikes with 12 or 24 VDC capability, fail-secure unless otherwise specified.
c. Where specified provide latch-bolt and latch-bolt strike monitoring indicating both the position of the latch-bolt and locked condition of the strike.
d. Manufacturers: One of the following or equal:
1) Folger Adam (FO) - 700 Series.
2) Folger Adam (FO) - 742 Series.
3) HES (HS) - 1006 Series.
4) HES (HS) - 1500/1600 Series.
5) HES (HS) - 4500 Series.

2.09 CONSTRUCTION KEYING

A. Type: Removable core system.

2.10 PERMANENT CYLINDERS AND KEYING

A. Manufacturers: One of the following or equal:
1. Corbin Russwin Hardware (RU).
2. Sargent Manufacturing (SA).
3. Schlage (SC).

B. Cylinders: Original manufacturer cylinders complying with the following:
1. Mortise type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-lock type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
5. Keyway: Manufacturer’s Standard. Match Facility Standard.

C. Removable cores: Provide removable cores as specified, core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

D. Keying system: Each type of lock and cylinders to be factory keyed.
   1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
   2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
   3. New system: Key locks to a new key system as directed by the Owner.

E. Key quantity: Provide the following minimum number of keys:
   1. Change keys per cylinder: 2.
   2. Master keys (per master key level/group): 5.
   3. Construction control keys (where required): 2.
   4. Permanent control keys (where required): 2.

F. Construction keying: Provide temporary keyed construction cores.

G. Key registration list (biting list):
   1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
   2. Provide transcript list in writing or electronic file as directed by the Owner.

2.11 PUSH/PULL PLATES

A. Manufacturers: One of the following or equal:
   1. Ives.
   2. Trimco.
   3. Rockwood.

B. Pulls:
   1. Material: As scheduled.
   2. Size: Minimum 8 inches center to center, minimum grip diameter of 3/4 inch, minimum projection of 2-1/4 inch.

C. Pull plates:
   1. Material: As scheduled.
   2. Plate size: Minimum 3 by 12 inches by 0.050-inch thick, with beveled edges on 4 sides with pull.
   3. Pull size: Minimum 8 inches center to center, minimum grip diameter of 3/4 inch, minimum projection of 2-1/4 inch.

D. Push plates:
   1. Material: As scheduled.
   2. Size: Minimum 3 by 12 inches by 0.050-inch thick, with beveled edges on 4 sides.

2.12 CLOSERS

A. Manufacturers:
   1. Features:
      a. Heavy-duty.
      b. Non-handed and non-sized.
      c. Adjustable spring power from size 1 through 4.
      d. Include Tee-handle stop hold open feature on all closers
      e. Manufacturer's special rust inhibitive epoxy primer on every part.
   2. One of the following or equal:
      a. Sargent, 351 Series.
      b. LCN, 4040XP HCUSH Door Closer with CUSH-N-STOP Heavy Duty Hold Open Parallel Arm.
      c. Norton Door Controls, Multi-Size Door Closers Model 7500BF Series.

B. Type: Full rack and pinion type with steel spring and non-gumming, non-freezing hydraulic fluid.

C. Controls: Separate set for regulating sweep speed, latch speed, backcheck and backcheck positioning, or where schedules, spring power.

D. Sizes: As recommended by accepted manufacturer.

E. Covers: Metal, capable of receiving finishes to match adjacent hardware finishes, unless otherwise specified.

F. Narrow frame provisions: Drop plates.

G. Effort to operate: As follows:
   1. Exterior: Maximum 8-1/2 pounds.
   2. Interior: Maximum 5 pounds.
   3. Fire-resistive rated doors: Maximum 15 pounds.

H. Adjust closers in accordance with manufacturer's directions for size of door.

2.13 EXIT DEVICES

A. Lever design:
   1. Manufacturers: The following or equal:
      a. Von Duprin, Lever Model 06.

B. Rim device, non-fire resistive rated:
   1. Manufacturers: One of the following or equal:
      a. Von Duprin Inc., Model Series 98.
      b. Sargent Essex Ind., Model Series 8800.

C. Rim device, fire-resistive rated:
   1. Manufacturers: One of the following or equal:
      a. Von Duprin Inc., Model Series 98-F.
      b. Sargent Essex Ind., Model Series 12-8800.

D. Mortise lock device, non-fire-resistive rated:
   1. Manufacturers: The following or equal:
      a. Von Duprin Inc., Model Series 9875L.

E. Mortise lock device, fire-resistive rated:
   1. Manufacturers: The following or equal:
      a. Von Duprin Inc., Model Series 9875L-F.

F. Material: As scheduled.

G. Corrosive environment provisions: Zinc dichromate coated internal parts.

2.14 MISCELLANEOUS DOOR HARDWARE

A. Wall stops: As scheduled.
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.
      c. Rockwood.

B. Floor stops: As scheduled with strike of suitable height to compensate for clearance between door and floor.
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.
      c. Rockwood.

C. Mechanical holders: Foot-operated plunger with instant release by touch of toe and integral spring to keep constant shoe pressure against floor; brass.
   1. Manufacturers: The following or equal:
      a. Glynn-Johnson.

D. Flush bolts and surface bolts:
   1. BHMA A156.3 and A156.16, Grade 1, certified.
      a. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately 6 feet from the floor.
      b. Furnish dust proof strikes for bottom bolts.
      c. Surface bolts to be minimum 8 inches in length, UL listed for labeled fire doors, and UL listed for windstorm components where applicable.
      d. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
      e. Manufacturers: One of the following or equal:
         1) Ives (IV).
         2) Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
         3) Trimco (TC).

E. Kick plates:
   1. As scheduled, 0.050-inch thick, beveled edges, 10 inches high, 1-1/2 inches narrower than single doors, 1 inch narrower than leaf of door pairs.

2. Manufacturers: One of the following or equal:
    a. Ives.
    b. Trimco.

F. Architectural seals:
1. General:
    a. Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets.
    b. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated.
    c. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
2. Smoke labeled gasketing:
    a. Assemblies in accordance with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing in accordance with UL 1784.
    b. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
3. Fire labeled gasketing:
    a. Assemblies in accordance with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing in accordance with UL 10C.
    b. Provide intumescent seals as indicated to meet UL 10C, and NFPA 252.
4. Sound-rated gasketing:
    a. Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
5. Replaceable seal strips:
    a. Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
6. Manufacturers: One of the following or equal:
    a. National Guard Products (NG).
    b. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
    c. Zero (ZE).

G. Thresholds:
1. As scheduled, extruded aluminum, maximum 1/2-inch high, maximum slope of 1 foot in 2 feet.
2. Manufacturers: One of the following or equal:
    a. National Guard Products Inc.
    b. Pemko Mfg. Co.

H. Dustproof strike:
1. As scheduled.
2. Manufacturers: One of the following or equal:
    a. Ives.
    b. Trimco.

I. Coordinator with filler bar:
   1. As scheduled, non-handed, series type length as required for door sizes indicated, complete with filer lengths as required, with mounting brackets and carry bars when required for proper operation; steel with manufacturer's standard prime finish capable of receiving painted finish.
   2. Manufacturers: One of the following or equal:
      a. Glynn-Johnson Coordinators, Model COR Series.
      b. Ives, Door Co-Ordinator, Model 900 Series.

J. Door bottoms:
   1. As scheduled, extruded aluminum with vinyl insert, surface mounted, length equal to door width minus 2 inches, automatic, recessed in bottom of door.
   2. Manufacturers: One of the following or equal:
      a. Pemko.
      b. Reese.

K. Astragals:
   1. As specified in Sections 08110 - Hollow Metal Doors and Frames.

L. Silencers:
   1. As scheduled, pneumatic gray rubber.
   2. Manufacturers: One of the following or equal:
      a. Trimco.
      b. Ives.
      c. Rockwood.

2.15 FINISHES

A. Brass and bronze: BHMA A156.18 626 (US26D), satin chrome.

B. Steel: BHMA A156.18 652 (US26D), satin chrome.

C. Stainless steel: BHMA A156.18 630 (US32D), satin stainless steel.

D. Aluminum: BHMA A156.18 628 (US28).

E. Plastic closer covers: Spray paint to match typical door hardware finish.

F. Metal closer covers: Plate covers to match typical door hardware finish.

G. Electromagnetic hold open devices: Manufacturer's standard brushed zinc finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect doors and door frames for damage or defects and examine hardware for compatibility with receiving conditions and suitable to intended use.

B. Verify that required wall backing has been installed.

3.02 INSTALLATION

A. Install finish hardware in accordance with manufacturer's templates and instructions.
   1. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
   2. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: Hanging devices; locking devices; closing devices; and seals.

B. Accurately and properly fit hardware.

C. Securely fasten fixed parts for smooth, trouble-free, non-binding operation.

D. Fit faces of mortise parts snug and flush.

E. Ensure that operating parts move freely and smoothly without binding, sticking, or excessive clearance.

F. Mounting heights:
   1. Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
   2. Standard steel doors and frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   3. Wood doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
   4. Where indicated to comply with accessibility requirements, in accordance with ICC A117.1 "Accessibility Guidelines for Buildings and Facilities."
   5. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

G. Retrofitting:
   1. Install door hardware to comply with manufacturer's published templates and written instructions.
   2. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Section 09910 - Painting.
   3. Do not install surface-mounted items until finishes have been completed on substrates involved.

H. Protection:
   1. Protect door hardware from damage or marring of finish during construction, use strippable coatings, removable tapes, or other acceptable means.
   2. Ensure door hardware displays no evidence of finish paint after final building cleanup with exception of prime-coated door hardware installed for finish painting.

I. Latch guard and dead bolts: Install so that bolts automatically engage in keeper, whether activated by closer or by manual pressure.

J. Closers:
   1. Mount on opposite sides of corridors or vestibules, except at exterior doors.
   2. Mount for 180 degree swing wherever possible.
   3. Mount with drop plates at narrow top rail doors.
   4. Adjust to operate noiselessly and evenly.
   5. Have closer manufacturer regulate closers prior to final acceptance of project.

K. Kick plates: Screw on push side of doors, unless otherwise indicated on the Drawings.

L. Gasketing: Mount to provide complete contact between door and frame, finished floor, or both; and weathertight enclosure.

M. Thresholds:
   1. Install immediately before inspection for Substantial Completion or protect from heavy traffic damage during construction.
   2. Cope to fit door frame profile and drill to suit required flush bolts and panic bolts.
   3. Unless indicated on the Drawings to be set in grout, set in double bead of sealant, tightly fit at jambs, and make waterproof.
   4. Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07900 - Joint Sealants.
   5. Fasten to concrete slab with 5/16-inch stainless steel flat head countersunk machine screws and concrete anchors at 8-inch centers.

N. Silencers:
   1. Insert into predrilled holes in frames.

O. Storage:
   1. Provide a secure lock up for hardware delivered to the project but not yet installed.
   2. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.03 DOOR HARDWARE SETS

A. They are a guideline only and should not be considered a detailed hardware schedule.

B. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

C. Quantities listed are for each pair of doors, or for each single door.

D. The Supplier is responsible for handing and sizing all products.

E. Where multiple options for a piece of hardware are given in a single line item, the Supplier shall provide the appropriate application for the opening.

F. Provide a list of Manufacturer's Abbreviations.

3.04 CONSTRUCTION KEYING

A. Insert construction inserts in cylinder cores of exterior doors, and doors requiring security and access for workman, unless otherwise directed by the Engineer.

3.05 ADJUSTING

A. Examine hardware in place for complete and proper installation. Lubricate bearing surfaces for proper function.

B. Replace, rework or otherwise correct defective door hardware, including incorrect hand or function.

3.06 CLEANING

A. Remove protective materials and devices and thoroughly clean exposed surfaces of hardware.

B. Check for surface damage prior to final cleaning for acceptance of project.

3.07 PERMANENT KEYING

A. Remove construction key inserts with extractor key. Insert permanent cylinders with cores.

B. Inspect each lockset to ensure permanent cylinders with cores are operating satisfactorily.

C. Test keys for proper conformance with keying system.

3.08 HARDWARE SCHEDULE

A. HW-1 Exterior Single Doors: 63-D101-01, 63-D101-02, 63-102-02, 63-102-03, 63-103-01, 63-104-01, 65-D101-01, 65-D102-01, 69-D101-01, 69-D102-02.

1 each	Electric Hinge	T4A 3386 4.5x4.5 Std CC8	US32D	McKinney
2 each	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
1 each	Exit Device	9875l-Nl X 996l-Nl-M	US32D	Von
1 each	Closer	4040XP HCush + Cush-N-Stop	689	LCN
1 each	Doorstop	271D	US26D	Hager
1 each	Weatherstrip	8144S	Brown	Zero
1 each	Door Sweep	539	AA	Zero
1 each	Threshold	556	A	Zero

1 each	Rain Drip	346c		PE
1 each	Electric Strike	6223 FS 12VDC	US32D	Von
1 each	Card Reader*	By Others		

*Coordinate with Electrical and I&C for card reader model and required connections.

B. HW-2 Exterior Double Doors: 63-D105-01, 65-D103-01.

1 on inactive	Electric Hinge	T4A 3386 4.5x4.5 Std CC8	US32D	McKinney
2 on inactive	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
3 on active	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
1 each	Coordinator	COR52	US26D	Ives
2 each	Coordinator Accessories	MB2 SP28	US26D	Ives
1 each	Exit Device	9875L-NL X 996L-NL-M	US32D	Von
1 set	Automatic Flush Bolt	FB318 P	US32D	Ives
1 each	Dust Proof Strike	DP2	626	Ives
1 each	Astragal	357 C	600	PE
1 each	Closer	4040XP HCush + Cush-N-Stop	689	LCN
1 each	Doorstop	271D	US26D	Hager
1 set	Weatherstrip	8144S	Brown	Zero
1 each	Door Sweep	539	AA	Zero
1 set	Threshold	556	A	Zero
1 each	Rain Drip	346C		PE
1 each	Electric Strike	6223 FS 12VDC	US32D	Von
1 set	Card Reader*	By Others		

*Coordinate with Electrical and I&C for card reader model and required connections.

C. HW-3 Interior Single Doors 63-103-02:

3 each	Hinge	TA 3386 4.5x4.5 HVY WGT NRP	US32D	McKinney
1 each	Closer	4040XP HCUSH + CUSH-N-STOP	689	LCN
1 each	Doorstop	271D	US26D	Hager
1 each	Weatherstrip	8144S	Brown	Zero
1 each	Door Sweep	539	AA	Zero
1 each	Threshold	556	A	Zero

D. HW-4 Interior Double Doors 69-102-01:

3 on inactive	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
3 on active	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
1 each	Coordinator	COR52	US26D	Ives
2 each	Coordinator Accessories	MB2 SP28	US26D	Ives
1 each	Exit Device	9875L-NL X 996L-NL-M	US32D	Von
1 set	Automatic Flush Bolt	FB318 P	US32D	Ives
1 each	Dust Proof Strike	DP2	626	Ives
1 each	Astragal	357 C	600	PE
1 each	Closer	4040XP HCush + Cush-N-Stop	689	LCN
1 each	Door Stop	271D	US26D	Hager
1 each	Door Sweep	539	AA	Zero
1 set	Threshold	556	A	Zero

E. HW-5 Exterior Oversized Double Doors: 30-D101-01:

1 on inactive	Electric Hinge	T4A 3386 4.5x4.5 Std CC8	US32D	McKinney
2 on inactive	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
3 on active	Hinge	TA 3386 4.5x4.5 Hvy Wgt NRP	US32D	McKinney
1 each	Coordinator	COR52	US26D	Ives
2 each	Coordinator Accessories	MB2 SP28	US26D	Ives
1 each	Exit Device	9875L-NL X 996L-NL-M	US32D	Von

1 set	Automatic Flush Bolt	FB318 P	US32D	Ives
1 each	Dust Proof Strike	DP2	626	Ives
1 each	Astragal	357 C	600	PE
1 each	Closer	4040XP HCush + Cush-N-Stop	689	LCN
1 each	Doorstop	271D	US26D	Hager
1 set	Weatherstrip	8144S	Brown	Zero
1 each	Door Sweep	539	AA	Zero
1 each	Electric Strike	6223 FS 12VDC	US32D	Von
1 set	Card Reader*	By Others		

*Coordinate with Electrical and I&C for card reader model and required connections.

END OF SECTION

SECTION 08800

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Glass and glazing.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z97.1 - Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.

B. ASTM International (ASTM):
   1. C1036 - Standard Specification for Flat Glass.
   2. C1048 - Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
   3. E773 - Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units.

C. Glass Association of North America (GANA):
   1. GANA Glazing Manual.

D. Insulating Glass Certification Council (IGCC):
   1. Certified Products Directory.

E. U.S. Consumer Product Safety Commission (CPSC):
   1. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

1.03 DEFINITIONS

A. Full Height Windows: Windows meeting the following conditions:
   1. Lowest edge is less than 18 inches above floor.
   2. Area is greater than 9 square feet.
   3. Walking surface is on both sides either of which is within 36 inches of window.
   4. Window has no minimum 1-1/2-inch railing or mullion at from 24 to 36 inches above floor.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings: Locations of glass types and typical glazing details.

C. Samples: As follows:
   1. Glazing sealants, 2-inch long beads, for color selection.
   2. Glass, 1 square foot of each type specified.

D. Certificates of compliance: Certification that tempered glass in accordance with ANSI Z97.1 and CPSC 16 CFR 1201.

E. Manufacturer's Installation Instructions.

1.05 DESIGN AND PERFORMANCE CRITERIA

A. Comply with the requirements of the building code specified in Section 01410 - Regulatory Requirements.

B. Provide glass and glazing that conforms to CPSC 16 CFR, Part 1201, and exit requirements of the building code.

C. Design and fabricate glazing for resistance to the following loads, as specified in Section 01850 - Design Criteria:
   1. Seismic loading.
   2. Wind loading, based on the requirements for "components and cladding."

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in manner to prevent damage.

B. Deliver and store packaged materials in original containers bearing manufacturer's name.

C. Deliver glass affixed with manufacturer's labels showing strength, grade, thickness, type and quality of glass, and for insulating glass, IGCC certification label.

D. Remove labels after installation, inspection, and final acceptance.

1.07 PROJECT CONDITIONS

A. Perform glazing when ambient air temperature is 40 degrees Fahrenheit or above.

1.08 WARRANTY

A. Warrant to replace insulating glass units that exhibit interpane dusting or misting within 10 years with new in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 GLASS

A. Clear monolithic: ASTM C1036, Type I, Class 1, Quality q3; minimum 1/4-inch thick.
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc.
      b. Guardian Industries Corp., Sunguard, Clear.

B. Tinted monolithic: ASTM C1036, Type I, Class 2, Quality q3; tinted light bronze; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Solarbronze.
      b. Guardian Industries Corp., Sunguard, bronze.

C. Tempered: ASTM C1048, Kind FT, Condition A, Type I, Class 1 or Class 2 as scheduled below, Quality q3; tempered without visible tong marks when installed; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Herculite.
      b. Guardian Industries Corp., equivalent product.

D. Insulating glass units: IGCC Rating Level CBA when tested in accordance with ASTM E773 and E774; hermetically sealed units consisting of minimum 1/4-inch thick, tinted exterior light, minimum 1/4-inch thick, clear interior light, and 1/2-inch wide air space, dehydrated with blended molecular sieve and silica gel desiccant, with metal spacer channel with bent corners and welded splice on 1 vertical side, and polyisobutylene primary and silicone secondary seals.
   1. Manufacturers: One of The following or equal:
      a. PPG Industries, Inc., Twindow.
      b. Guardian Industries Corp., equivalent product.

E. Wired monolithic: ASTM C1036, Type II, Class 1, Form 1, Quality q8, Mesh m2; minimum 1/4-inch thick.

F. Spandrel monolithic: ASTM C1048, Kind HS, Condition B, Class 2, Quality q3; tinted to match adjacent tinted glass; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Spandrelite.
      b. Guardian Industries Corp., equivalent product.

2.02 GLAZING MATERIALS

A. Setting blocks: Neoprene, 80 to 90 durometer.

B. Spacer blocks: 30 to 40 durometer, thickness equal or greater than insulated window thickness by minimum 6 inches long.

C. Pressure tape: Butyl rubber tape:
   1. Manufacturers: One of the following or equal:
      a. Tremco Mfg. Co., Tremco 440 Tape.
      b. 3-M Co., Weatherban 5422.

D. Sealant: Silicone:
   1. Manufacturers: One of the following or equal:
      a. General Electric Co., Silicone Construction Sealant Series SCS-1200.
      b. Dow Corning Corp., 999-A, Silicone Building and Glazing Sealant.

E. Glazing gaskets and other materials for exterior openings:
   1. As specified in Section 08412 - Aluminum-Framed Entrances and Storefronts.

2. As specified in Section 08520 - Aluminum Windows.

2.03 SOURCE QUALITY CONTROL

A. Allowable bow and warp tolerances: As measured with glass resting on edge upon two 1 inch wide supports:
   1. Typical: Maximum 1/8 inch in 48 inches.
   2. Tempered glass: Maximum allowed in accordance with ASTM C1048.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine openings to receive glass for defects that would affect glass and glazing work.

B. Verify removal of rivets, screws, bolts, welding fillets, or other projections from clearances in glazing rabbets.

3.02 PREPARATION

A. Examine frames receiving glass and ensure surfaces are clean and dry.

B. Remove dust and oil from glass by wiping clean immediately before installation.

C. Verify that sealants are compatible with glazing materials.

3.03 INSTALLATION OF MONOLITHIC GLASS

A. In accordance with GANA Glazing Manual, manufacturer's instructions, and accepted shop drawings by the Engineer.

B. Glaze doors in closed position after hanging and adjustment.

C. Accurately size and cut glass clean for each glazing condition:
   1. Do not nip edges.

D. Cut and set glass to full fit and play consistent with expansion and contraction requirements and at exterior for absolute security under maximum high velocity wind and vacuum stresses.

E. Maintain edge clearance at least equal to glass thickness from perimeter of glass to inside of rabbet.

F. Maintain 1/8-inch clearance between faces of glass and adjacent stop or bead.

G. Maintain minimum bite of 3/8 inch.

H. Set glass as required to ensure against optical distortion.

3.04 INSTALLATION OF INSULATED GLASS UNITS

A. In accordance with GANA Glazing Manual, manufacturer's instructions, and accepted shop drawings by the Engineer.

B. Use wet and dry glazing method.

C. Cut glazing tape to length and set against permanent stops to project 1/16 inch above sight line.

D. Place setting blocks at quarter points and no closer than 6 inches from corners.

E. Rest glazing on setting blocks and push against tape for full contact at perimeter of unit.

F. Place glazing gasket.

G. Install removable stop with concealed leg notched to accommodate setting blocks.

H. Align top of gasket with stops.

3.05 INSTALLATION OF GASKETS

A. Gaskets: Install in accordance with manufacturer's instructions.

B. Glazing of interior metal frames: Use pressure or foamed tape and sealant as indicated as required to eliminate rattle and reduce sound transmission.

3.06 SEALANT APPLICATION

A. As specified in Section 07900 - Joint Sealants, unless specifically noted otherwise.

B. Ensure protective coatings have been removed from aluminum surfaces.

C. Where setting blocks and spacer shims are required to be set in sealant, butter with sealant, place into position, and allow to set prior to installation of glass.

D. Neatly tool sealant or compound joints to compress material and improve adhesion. Repair or replace pockets exposed by tooling.

3.07 CLEANING

A. After inspection by Engineer, remove labels and marks from glass in accordance with manufacturer's published recommendations.

B. Clean glass and surrounding surfaces from spatter and blemishes resulting from glazing operations.

C. Clean and polish glass inside and outside.

D. Clean glass with a soft, clean, grit-free cloth and mild soap, detergent, or slightly acidic cleaning solution:
   1. Immediately rinse with clean water and remove excess rinse water with a clean squeegee.
   2. Do not use an abrasive cleaner.

E. Remove grease and miscellaneous glazing materials with commercial solvent. Follow with normal wash and rinse.
   1. Be careful not to damage joint sealers.

3.08 GLASS AND LOCATION SCHEDULE

A. Exterior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:
   1. Typical: Insulating, tinted.
   2. Non-fire-rated doors: Tinted and tempered.
   3. Fire-rated doors: Wired.
   4. Fire-rated windows: Wired.
   5. Entrance doors: Tempered and tinted.
   6. Windows within 48 inches of doors: Insulating, tinted, and tempered.
   7. Full height windows: Insulating, tinted, and tempered.
   8. Spandrels: Spandrel, tinted.

B. Interior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:
   1. Typical: Clear, non-tempered.
   2. Non-fire-rated doors: Clear and tempered.
   3. Fire-rated doors: Wired.
   4. Fire-rated windows: Wired.
   5. Windows within 48 inches of doors: Clear and tempered.
   6. Full-height windows: Clear and tempered.

C. Public toilet mirrors: Mirrors, sizes as indicated on the Drawings.

END OF SECTION

SECTION 08810

FIRE RATED GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Fire rated glazing for installation as vision lights in fire rated doors, full vision fire rated doors, windows, and transoms.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C1036 - Standard Specification for Flat Glass.
   2. C1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.

B. Underwriters' Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Shop drawings.

C. Samples:
   1. Glazing:
      a. 2-inch square samples.
   2. Sealants:
      a. 2-inch square samples.
   3. Install 12-inch long sealant samples between two strips of material representative in color of the adjoining framing system.

D. Glazing schedule:
   1. Use same designations indicated on the Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

E. Product data: Submit latest edition of manufacturer's product data providing product descriptions, technical data and installation instructions.
   1. Demonstrate certification by showing an approved independent agency, such as UL approval.

1.04 QUALITY ASSURANCE

A. Certification by an approved independent agency, such as UL approval.

B. Source limitations for glazing accessories: Obtain glazing accessories from 1 source for each product and installation method indicated.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle in accordance with manufacturer's instructions.

B. Deliver materials to specified destination in manufacturer or distributor's packaging undamaged, complete with installation instructions.

C. Store off ground, under cover, protected from weather and construction activities.

1.06 WARRANTY

A. As specified in Section 01783 - Warranties and Bonds.

PART 2 PRODUCTS

2.01 GLAZING MATERIAL

A. Manufacturers: One of the following or equal:
   1. Technical Glass Products, FireLite IGU fire-rated glazing.
   2. Vetrotech, Comparable product.
   3. Pyran Platinum, Comparable product.

B. Fire rated glazing:
   1. In accordance with ASTM C1036 and ASTM C1048.

C. Approximate visible transmission:
   1. Varies with thickness with approximate range of 88 percent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install by a specialty contractor with appropriate experience qualifications and in strict accordance with the approved shop drawings.

B. Install glazing in accordance with manufacturer's instructions.

C. Field cutting or tampering with product is not permissible.

3.02 PROTECTION AND CLEANING

A. Protect glass from damage immediately after installation by attaching crossed streamers to framing held away from glass.
   1. Do not apply markers to glass surface.
   2. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter.
   1. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately in accordance with manufacturer's instructions.

C. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism during construction period.

D. Wash glass in accordance with manufacturer's instructions on both exposed surfaces in each area of Project not more than 4 days before date scheduled for inspections that establish date of Substantial Completion.

END OF SECTION

SECTION 08910

LOUVERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. A variety of stationary and combination louvers.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 500-L - Laboratory Methods of Testing Louvers for Rating.
   2. 500-D - Laboratory Methods of Testing Dampers for Rating.
   3. 511 - Certified Ratings Program - Product Rating Manual for Air Control Devices.

B. American Society of Civil Engineers (ASCE):
   1. 7 - Minimum Design Loads and Associated Criteria for Building and Other Structures.

C. ASTM International (ASTM):
   1. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
   2. D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.

D. Testing Application Standard (TAS):
   1. 100A - Standard Test Procedure for Wind and Wind Driven Rain Resistance and/or Increased Windspeed Resistance of Soffit Ventilation Strip and Continuous or Intermittent Ventilation System Installed.

E. Underwriters Laboratories, Inc. (UL).

1.03 TERMINOLOGY

A. The words and terms listed below, are not defined terms that require initial capital letters, but, when used in this Section have the indicated meaning.
   1. Drainable-blade louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

1.04 SUBMITTALS

A. As specified in Section 15500 - Common Work Results for HVAC.

1.05 QUALITY ASSURANCE

A. Provide louvers with the following, unless otherwise specified:
   1. AMCA certification and rating in accordance with AMCA 511 for air performance and water penetration.

B. Louvers shall be factory engineered to withstand the specified seismic loads.
   1. Minimum design loads shall be calculated to comply with ASCE 7, or local requirements of Authority Having Jurisdiction (AHJ).

PART 2 PRODUCTS

2.01 GENERAL

A. Louver types: As indicated on the Drawings.
   1. Identify louvers with a letter L followed by a number referring to a louver type in this Section.
   2. Identify individual louver size and airflow rates.

B. Accessories:
   1. Provide installation clips and flanged or jamb-mounting styles suitable for the mounting locations.
   2. As indicated on the Drawings.
   3. Provide extended sills for louvers indicated as installed recessed from the exterior wall surface.
   4. Provide stainless steel fasteners unless noted otherwise.
   5. Corrosion protection.
   6. Provide gravity damper for outside air intake and exhaust louvers, unless noted otherwise.

C. Protective coatings for aluminum in contact with concrete or masonry:
   1. Manufacturers: One of the following or equal:
      a. Koppers Co., Inc.
      b. Porter Coatings.
      c. Tarmastic 100.

2.02 DESIGN AND PERFORMANCE REQUIREMENTS

A. Performance: In accordance with AMCA 511 when tested in accordance with AMCA 500.

B. Designed for 20 pounds per square foot wind load.

C. Provide instrumentation and controls to meet the equipment operating requirements as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

D. Louvers for severe windstorm applications:
   1. Shall resist the cyclic pressures, static pressures, and missile impact loads in accordance with:
      a. Applicable building codes as specified in Section 01410 - Regulatory Requirements.
   2. Shall resist wind driven rain in accordance with:
      a. TAS 100A:
         1) Louvers shall not require the use of a manual damper to meet the certification requirements.

2.03 STATIONARY WEATHER LOUVERS, TYPE L-1

A. Manufacturers: One of the following or equal:
   1. Greenheck ESD-603.
   2. Ruskin ELF6375DX.
   3. Airolite Co.

B. Requirements:
   1. Type: Stationary louver with drainable blades.
   2. Frame: 6-inches deep, minimum 0.125-inch thick, Type 6063-T5 aluminum with downspouts and caulking channel provided.
   3. Blades: Minimum 0.125-inch thick, Type 6063-T5 aluminum drainable blades spaced at 6-inch centers, stationary mounted at 37 degrees.
   4. Screens: Removable aluminum frame with aluminum wire; insect screens on intakes and bird screens on exhausts.
   5. Pressure drop (without screen): Maximum 0.15-inch water column for exhaust service and 0.15-inch water column for intake service at 1,000 feet per minute free area velocity.
   6. Water penetration: Maximum 0.01-ounce water per square foot at 1,027 feet per minute free area velocity.
   7. Mullions: Hidden.
   8. Finish: Kynar finish; color as selected.
   9. Motorized dampers: As indicated on Drawings.

2.04 COMBINATION LOUVERS, TYPE L-10

A. Manufacturers: One of the following or equal:
   1. Greenheck EACA-601.
   2. Arrow.
   3. Ruskin.

B. Requirements:
   1. Type: Combination drainable blade weather louver with adjustable rear blades.
   2. Frame: 6-inches deep, minimum 0.125-inch thick 6063-T5 aluminum; provide downspouts, caulking slots and flexible aluminum jamb seals.
   3. Front stationary blades: Minimum 0.081-inch (12-gauge) thick 6063-T5 aluminum, spaced at 6.5-inch centers, mounted at 37 degrees, drainable J style design.
   4. Rear adjustable blades: Minimum 0.14-inch thick 6063-T5 aluminum double skin air foil 0.14 with vinyl edge seals.

5. Bearings and axles: Stainless steel sleeve bearing pressed into the frame; 0.5-inch plated steel hex axle.
6. Linkage and actuator: Concealed linkage with locking quadrant for manual lever actuator; when motor operator indicated on the Drawings provide 2-position, spring-return, 120 volts alternating current to open actuator with torque to match louver requirements, 60-inch pound minimum.
7. Mullions: Hidden.
8. Screens: Removable aluminum screen in frame; insect screens on intakes and bird screens on exhausts.
9. Water penetration: Maximum 0.01 ounce water per square foot at 1,020 feet per minute free area velocity.
10. Pressure drop (without screen): Maximum 0.12-inch water column for intake service and 0.15-inch water column for exhaust service at 1,000 feet per minute free area velocity.
11. Finish: Kynar, color as selected.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect areas to receive louvers.
   1. Notify the architect of conditions that would adversely affect the installation or subsequent utilization of the louvers.
   2. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Clean opening thoroughly prior to installation.

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

3.03 INSTALLATION

A. Install louvers at locations indicated on the Drawings and in accordance with manufacturer’s instructions.

B. As specified in Section 15500 - Common Work Results for HVAC.

3.04 FIELD QUALITY CONTROL

A. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.05 SCHEDULES

A. As indicated on the Drawings.

END OF SECTION

SECTION 09910

PAINTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Field applied paints and coatings for normal exposures.
   2. Painting Accessories.

1.02 DEFINITIONS

A. Paints: Manufacturer's best ready-mixed coatings, except when field catalyzed, with fully ground pigments having soft paste consistency and capable of being readily and uniformly dispersed to complete homogeneous mixture, having good flowing and brushing properties, and capable of drying or curing free of streaks or sags.

B. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon.

1.03 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Shop drawings: Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

C. Product data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.

D. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

E. Manufacturer's instructions: Submit in accordance with requirements for Product Data. Include:
   1. Special requirements for transportation and storage.
   2. Mixing instructions.
   3. Shelf life.
   4. Pot life of material.
   5. Precautions for applications free of defects.
   6. Surface preparation.
   7. Method of application.
   8. Recommended number of coats.
   9. Recommended thickness of each coat.
   10. Recommended total thickness.

11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.
16. Time allowed between coats.
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.

1.04 QUALITY ASSURANCE

A. Products: First line or best grade.

B. Materials for each paint system: By single manufacturer.

C. Applicator qualifications: Applicator of products similar to specified products with minimum 3 years of experience.

D. Regulatory requirements: Comply with by using paints that do not exceed governing agency's VOC limits or do not contain lead.

E. Field samples:
1. Paint 1 complete surface of each color scheme to show colors, finish texture, materials, and workmanship.
2. Obtain approval before painting other surfaces.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as specified in Section 01600 - Product Requirements.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying:
1. Manufacturer's name.
2. Brand name.
3. Product type.
4. Batch number.
5. Date of manufacturer.
6. Expiration date or shelf life.
7. Color.
8. Mixing and reducing instructions.

D. Store coatings in well-ventilated facility that provides protection from the sun weather, and fire hazards.
1. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.06 ENVIRONMENTAL CONDITIONS

A. Surface moisture contents: Do not paint surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:
   1. Plaster and gypsum wallboard: 12 percent.
   2. Masonry, concrete and concrete block: 12 percent.
   3. Interior located wood: 15 percent.
   4. Concrete floors: 7 percent.

B. Do not paint or coat:
   1. Under dusty conditions.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 50 degrees Fahrenheit or unless manufacturer allow a lower temperature.
   4. When relative humidity is higher than 85 percent, unless manufacturer allows a higher relative humidity.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.
   7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
   8. Apply clear finishes at minimum 65 degrees Fahrenheit.

C. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 50 degrees Fahrenheit for 24 hours before, during and 48 hours after application of finishes.

1.07 PROTECTION

A. Protect adjacent surfaces from paint and damage. Repair damage resulting from inadequate or unsuitable protection.

B. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

C. Place cotton waste, cloths, and material that may constitute fire hazard in closed metal containers and remove daily from site.

D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations.
   1. Carefully store, clean and replace on completion of painting in each area.
   2. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

1.08 EXTRA MATERIALS

A. Extra materials: Deliver as specified in Section 01770 - Closeout Procedures. Include minimum 1 gallon of each type and color of coating applied:
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
   2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type, and color.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Paints: One of the following or equal:
   1. Carboline: Carboline.
   2. PPG Paints/PMC.
   3. Rustoleum: Rustoleum Corp.
   4. S/W: Sherwin-Williams Co.
   5. Tnemec: Tnemec Co.

B. Submit requests for substitutions as specified in Section 01600 - Product Requirements:
   1. Include certified ingredient analyses.
   2. Provide colors that match specified colors.

2.02 PRETREATMENT, PRIMERS, PRIMER-SEALERS, AND WOOD STAIN

A. Aluminum primer:
   1. Manufacturers: One of following or equal:
      a. Carboline Co.: Carbocrylic 120.
      b. PPG: Pitt-Tech® Plus 4020 PF Interior/Exterior Primer/Finish, 4020PF.
      c. Sherwin-Williams Co.: DTM Wash Primer.

B. Concrete masonry filler/primer:
   1. Manufacturers: One of following or equal:
      a. Carboline Co.: Sanitile 100.
      b. PPG: Perma-Crete® Interior/Exterior Block & Masonry Surfacer/Filler, 4-100XI.
      c. Sherwin-Williams Co.: HD Block Filler, B42W46.
      d. Tnemec:
         1) Series 130, Envirofill.
         2) Series 180, Tneme-crete.

C. Concrete, porous, filler/primer:
   1. Manufacturers: One of following or equal:
      a. Carboline Co.: Sanitile 100.
      b. PPG: Perma-Crete® Interior/Exterior Block & Masonry Surfacer/Filler, 4-100XI.
      c. Sherwin-Williams Co.: HD Block Filler, B42W46.

d. Tnemec:
    1) Series 130, Envirofill.
    2) Series 180, Tneme-crete.

D. Concrete, smooth, filler/primer:
    1. Manufacturers: One of following or equal:
        a. Carboline Co.: Sanitile 100.
        b. Carboline Co.: Carbocrylic 120.
        c. PPG:
            1) Perma-Crete® Interior/Exterior Block & Masonry Surfacer/Filler, 4-100XI.
            2) Seal Grip® Hydrosealer Exterior Bonding Primer/Sealer, 17-6001.
        d. Sherwin-Williams Co.:
            1) HD Block Filler, B42W46.
            2) Epoxy Masonry Tilt Primer White B42WW49.
        e. Tnemec: Series 180, Tneme-Crete.

E. Ferrous metal primer:
    1. Manufacturers: One of following or equal:
        a. Carboline Co.: Carboguard 890.
        b. PPG: PITT-GUARD® Rapid-Coat Direct-to-Rust Epoxy Mastic Coating, 95-245 Series.
        c. Sherwin-Williams Co.: Macropoxy 646.
        d. Tnemec: Series 104.

F. Galvanized metal surface pretreatment materials:
    1. Manufacturers: One of following or equal:
        a. Carboline Co.: Surface Cleaner 3.
        b. PPG: Duraprep® Concentrated Degreaser, Prep125.

G. Galvanized metal surface primer:
    1. Manufacturers: One of following or equal:
        a. Carboline Co.: Carboguard 890.
        b. PPG: PITT-GUARD® Rapid-Coat Direct-to-Rust Epoxy Mastic Coating, 95-245 Series Sherwin-Williams Co.: Macropoxy 646.
        c. Tnemec: Series 104.

H. Plaster sealer:
    1. Manufacturers: One of following or equal:
        a. Carboline Co.: Sanitile 120.
        b. PPG: Seal Grip® Gripper® Universal Interior/Exterior Primer/Sealer, 17-921XI.
        c. Sherwin-Williams Co.:
            1) Promar 200 Primer B28W8200.
            2) Loxon Masonry Primer A24W300.

I. Plywood, latex finishes:
    1. Manufacturers: One of following or equal:
        a. Carboline Co.: Sanitile 120.

b. PPG:
    1) Exterior: Seal Grip® Hydrosealer Exterior Bonding Primer/Sealer, 17-6001.
    2) Interior: PPG Seal Grip Gripper Interior/Exterior 100 percent Acrylic Latex Primer, 17-921XI Series.
c. Sherwin-Williams Co.: A100 Latex Primer B42W8041.

2.03 PAINTS, INTERIOR EXPOSURE

A. Latex, flat:
1. Manufacturers: One of following or equal:
    a. Carboline Co.: Carbocrylic 3359 MC flat.
    b. PPG:
        1) Speedhide® Zero Interior Flat, 6-5110 Series.
        2) Ultralast Interior Matte, 13-210 Series.
    c. Sherwin-Williams Co.: Promar 200, B30W200.

B. Latex, semi-gloss:
1. Manufacturers: One of following or equal:
    a. Carboline Co.: Carbocrylic 3359 MC.
    b. PPG:
        1) Speedhide® Zero Interior Semi-Gloss, 6-5510 Series.
        2) Copper Armor Interior Latex Paint + Primer Semi-Gloss, 29-1510.
    c. Sherwin-Williams Co.: Promar 200, B77W3402D.

C. Alkyd, gloss:
1. Manufacturers: One of following or equal:
    a. PPG:
        1) 7-Line Interior/Exterior Industrial Gloss Oil, 7-282 Series.
        2) Break-Through!® 250 Interior/Exterior Gloss, V70-6102500.
    b. Sherwin-Williams Co.:
        1) Industrial Enamel, B54Z -100.
        2) Water based Industrial Enamel, B53W311.

D. Acrylic, semi-gloss:
1. Manufacturers: One of following or equal:
    a. Carboline Co.: Carbocrylic 3359 MC.
    b. PPG:
        1) Speedhide® Zero Interior Semi-Gloss, 6-5510 Series.
        2) Copper Armor Interior Latex Paint + Primer Semi-Gloss, 29-1510.
    c. Sherwin-Williams Co.: Promar 200, B77W3402D.
    d. Tnemec: Series 1029, Enduratone.

2.04 PAINTS, EXTERIOR EXPOSURE

A. Latex, flat:
1. Manufacturers: One of following or equal:
    a. Carboline Co.: Carbocrylic 3359 MC flat.

b. PPG:
1) Speedhide® Exterior Flat, 6-6510XI.
c. Sherwin-Williams Co.: A-100, Flat Exterior Latex A6-100.
d. Tnemec: 1028 Enduratone.

B. Alkyd, gloss:
1. Manufacturers: One of following or equal:
a. PPG:
1) 7-Line Interior/Exterior Industrial Gloss Oil, 7-282 Series.
2) Break-Through! 250 Interior/Exterior Gloss, V70-6102500.
b. Sherwin-Williams Co.:
1) Industrial Enamel, B54Z -100.
2) Water based Industrial Enamel B53W311.

C. Acrylic latex, semi-gloss:
1. Manufacturers: One of following or equal:
a. Carboline Co.: Carbocrylic 3359 MC flat.
b. PPG:
1) Speedhide® Exterior Semi-Gloss, 6-901XI.Sherwin-Williams Co.: A-100, Flat Exterior Latex A6-100.
c. Tnemec: 1028 Enduratone.

PART 3 EXECUTION

3.01 INSPECTION

A. Thoroughly examine surfaces scheduled to be painted before starting work.

B. Start painting when unsatisfactory conditions have been corrected.

3.02 SURFACE PREPARATION

A. Prepare surfaces in accordance with paint manufacturer's instructions or when none, the following:
1. Aluminum:
a. Remove surface contamination by steam, high-pressure water, or degreasers.
b. Abrade surface by abrasive blasting, power tool cleaning or hand tool cleaning.
c. Apply etching primer.
2. Reinforced concrete panels:
a. Remove dirt, powdery residue, and foreign matter.
b. Paint immediately; both sides when applicable.
3. Concrete floors:
a. Remove contamination, abrasive blast or acid etch and rinse with clear water.
b. Ensure required acid-alkali balance is achieved. Allow to dry thoroughly.
4. Copper for paint finish:
a. Remove contamination by steam, high-pressure water, or degreasers.

b. Abrade surface by abrasive blasting, power tool cleaning or hand tool cleaning.
c. Apply vinyl etch primer.

5. Copper for oxidized finish:
   a. Remove contamination.
   b. Apply oxidizing solution of copper acetate and ammonium chloride in acetic acid.
   c. Rub on repeatedly for correct effect.
   d. Once attained rinse surfaces well with clear water and allow to dry.
6. Galvanized surfaces:
   a. Remove surface contamination and oils and wash with degreasers.
   b. Apply coat of etching type primer.
7. Zinc coated surfaces: Remove surface contamination and oils and prepare for priming in accordance with metal manufacturer's recommendations.
8. Concrete and concrete masonry:
   a. Remove dirt, loose mortar, scale, powder and other foreign matter.
   b. Remove oil and grease with solution of tri-sodium phosphate.
   c. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate.
   d. Rinse well and allow to thoroughly dry.
   e. Spot prime exposed metal with alkyd primer.
9. Unprimed steel and iron: Remove grease, rust, scale, dirt and dust by wire brushing, sandblasting or other necessary method.
10. Shop primed steel:
    a. Sand and scrape to remove loose primer and rust.
    b. Feather out edges to make touch-up patches inconspicuous.
    c. Clean surfaces.
    d. Prime bare steel surfaces.

3.03 APPLICATION

A. Apply each coat at proper consistency.

B. Tint each coat of paint slightly darker than preceding coat.

C. Sand lightly between coats to achieve required finish.

D. Do not apply finishes on surfaces that are not sufficiently dry.

E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

F. Where clear finishes are required ensure tint fillers match wood.
   1. Work fillers well into grain before set.
   2. Wipe excess from surface.

G. Backprime exterior woodwork, which is to receive paint finish, with exterior primer paint.

H. Backprime interior woodwork, which is to receive paint or enamel finish, with enamel undercoat paint.

I. Backprime interior and exterior woodwork, which is to receive stain or varnish finish, with gloss varnish reduced 25 percent with mineral spirits.

J. Prime top and bottom edges of wood and metal doors with enamel undercoat when they are to be painted.

K. Prime top and bottom edges of wood doors with gloss varnish when they are to receive stain or clear finish.

3.04 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Identify equipment, ducting, piping, and conduit in accordance with Related Sections.

B. Remove grilles, covers, and access panels for mechanical and electrical system from location and paint separately.

C. Finish paint primed equipment with color selected by the Engineer.

D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are plated or covered with prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when painted over or spattered.

F. Paint interior surfaces of air ducts, convector, and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

G. Paint dampers exposed immediately behind louvers, grilles, convector, and baseboard cabinets to match face panels.

H. Paint exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.

I. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit, exposed ductwork, and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with the Contract Documents.

3.05 SURFACES NOT REQUIRING FINISHING

A. Stainless steel, brass, bronze, copper, Monel®, chromium, anodized aluminum: Specially finished articles such as porcelain enamel, plastic coated fabrics, and baked enamel.

B. Finished products such as ceramic tile, windows, glass, brick, resilient flooring, acoustical tiles, board and metal tees; other architectural features, such as finish

hardware, furnished in aluminum, bronze or plated ferrous metal, prefinished panels, or other items that are installed prefinished.

C. Items completely finished at factory, such as preformed metal roof and wall panels, aluminum frames, toilet compartments, sound control panels, acoustical tiles, shower compartments, folding partition, and flagpole.

3.06 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed, or spattered.

B. During progress of work, keep premises free from unnecessary accumulation of tools, equipment, surplus materials, and debris.

C. Upon completion of work, leave premises neat and clean.

3.07 INTERIOR PAINT SCHEDULE

A. Concrete masonry: 2 coats of following finish paints over block filler:
   1. Latex, semi-gloss:
      a. Walls, where scheduled.

B. Concrete, porous: 2 coats of following finish paints over block filler:
   1. Latex, semi-gloss:
      a. Walls, where scheduled.

C. Concrete, smooth: 2 coats of following finish paints over specified sealer:
   1. Latex, semi-gloss:
      a. Walls, where scheduled.

D. Gypsum board: 2 coats of following finish paints:
   1. Latex, flat:
      a. Ceilings.
   2. Latex, semi-gloss:
      a. Walls and partitions.

E. Metal, galvanized: 2 coats of following finish paints over specified primer:
   1. Acrylic, semi-gloss:
      a. Surfaces not scheduled otherwise.

F. Metal, interior doors and frames, galvanized: 2 coats of following finish paints over specified primer:
   1. Acrylic, semi-gloss:
      a. Surfaces not scheduled otherwise.

G. Metal, non-galvanized ferrous: 2 coats of following finish paints over specified primer:
   1. Acrylic, semi-gloss:
      a. Surfaces not scheduled otherwise.

3.08 EXTERIOR PAINT SCHEDULE

A. Aluminum: 2 coats of following finish paints over specified primer:
   1. Acrylic, semi-gloss:
      a. Surfaces not scheduled otherwise.

B. Concrete masonry: 2 coats of following finish paints over specified block filler:
   1. Latex, flat:
      a. Surface not scheduled otherwise.

C. Concrete, porous: 2 coats of following finish paints over specified primer.
   1. Latex, flat:
      a. Surfaces not scheduled otherwise.

D. Concrete, smooth: 2 coats of following finish paints over specified primer:
   1. Latex, flat:
      a. Surface not scheduled otherwise.

E. Metal, ferrous: Following finish coat over specified primer:
   1. Acrylic, semi-gloss:
      a. Surface not scheduled otherwise.

F. Metal, galvanized: 2 coats of following finish paints over pretreatment and specified primer:
   1. Acrylic, semi-gloss:
      a. Surface not scheduled otherwise.

END OF SECTION

SECTION 09960

HIGH-PERFORMANCE COATINGS

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Coatings, including coating systems, surface preparation, application requirements, and quality control requirements.

1.02 REFERENCES

A. Abbreviations:
   1. CMU - Concrete masonry units.
   2. CSA - Coating system applicator. Specialty subcontractor retained by the Contractor to install the coating systems specified in this Section.
   3. CSM - Coating system manufacturer.
   4. CTR - Coating system manufacturer's technical representative.
   5. DFT - Dry-film thickness. Thickness of cured film, usually expressed in mils (0.001 inch).
   6. VOC - Volatile organic compound. Portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing; expressed in grams per liter (g/l) or pounds per gallon (lb/gal). VOC is determined by EPA Method 24.
   7. WFT - Wet film thickness. Coating thickness as measured immediately after application. Usually expressed in mils (0.001 inch).

B. Standards:
   1. ASTM International (ASTM):
      a. D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
      b. D2200 - Standard Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces.
      c. D3359 - Standard Test Methods for Rating Adhesion by Tape Test.
      d. D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
      e. D4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      f. D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      g. D4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.
      h. D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
      i. D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast-Cleaned Steel.
      j. D4541 - Standard Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
      k. D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
      l. D5162 - Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.

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. International Concrete Repair Institute (ICRI):
   a. 310.2 - Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
3. NACE International (NACE):
   a. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
   b. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. 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.
5. NSF International (NSF):
   a. 61 - Drinking Water System Components - Health Effects.
6. Occupational Safety and Health Administration (OSHA).
7. Society of Protective Coatings (SSPC):
   a. Glossary - SSPC Protective Coatings Glossary.
   b. Guide 6 - Guide for Containing Surface Preparation Debris Generated during Paint Removal Operations.
   c. PA 1 - Shop, Field, and Maintenance Painting of Steel.
   d. PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   e. PA 9 - Measurement of Dry Coating Thickness Using Ultrasonic Gages.
   f. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
   g. SP 1 - Solvent Cleaning.
   h. SP 3 - Power Tool Cleaning.
   i. SP 5 - White Metal Blast Cleaning.
   j. SP 10 - Near-White Metal Blast Cleaning.
   k. SP 11 - Power Tools Cleaning to Bare Metal.
   l. SP 13 - Surface Preparation of Concrete.
   m. SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   n. SP COM - Surface Preparation Commentary.
   o. SP VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
   p. SP WJ-1 - Waterjet Cleaning of Metals—Clean to Bare Substrate.
   q. SP WJ-2 - Waterjet Cleaning of Metals—Very Thorough Cleaning.
   r. SP WJ-3 - Waterjet Cleaning of Metals—Thorough Cleaning.
   s. SP WJ-4 - Waterjet Cleaning of Metals—Light Cleaning.

1.03 TERMINOLOGY

A. Definitions used in this Section are in accordance with definitions referenced in ASTM D16, ASTM D3960, and SSPC Glossary of Definitions.

B. The words and terms listed below are not defined terms that require initial capital letters, but, when used in this Section, have the indicated meaning.
   1. Abrasive: Material used for blast cleaning, such as sand, grit, or shot.
   2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.
   3. Anchor Pattern: Profile or texture of prepared surface(s).
   4. Biogenic Sulfide Corrosion: Corrosion caused by sulfuric acid formed when *Thiobacillus* bacteria metabolizes hydrogen sulfide.
   5. Bug Holes: Small cavities resulting when air bubbles are entrapped in the surface of formed concrete during placement and consolidation.
   6. Coating/Paint/Lining Thickness: Total thickness of primer, intermediate, and/or finish coats after drying or curing.
   7. Dew point: Temperature a given air/water vapor mixture starts to condense.
   8. Dry to Recoat: Time interval between material application and its ability to receive the next coat.
   9. Dry to Touch: Time interval between material application and its ability to tolerate a light touch without coating damage.
   10. Drying Time: Time interval between application and material curing.
   11. Exposed Surface: Any indoor or outdoor surface not buried or encased.
   12. Feather Edging: Reducing coating thickness at its edge to blend with existing surrounding coating.
   13. Feathering: Tapering off a wet edge with a comparatively dry brush.
   14. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
   15. Field Coat: Application of a surface coating system at the work site.
   16. Finish Coat: Final coat in a paint system, including texture, color, smoothness of surface, and other properties affecting appearance.
   17. Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
   18. Holiday: A discontinuity, skip, void, or pinhole in coating or coating system film that exposes the substrate.
   19. Honeycomb: Segregated and porous surface of hardened concrete due to insufficient consolidation.
   20. Hydroblast: High or ultra-high-pressure water jet surface preparation.
   21. Immersed/Immersion: A service condition in which substrate is submerged, is immediately above liquids, or is subject to frequent wetting, splashing, or washdown.
   22. Incompatibility: One coating’s inability to overlay another coating or surface as evidenced by bleeding, poor bonding, or lifting of old coating; inability of a coating to bond to a substrate.
   23. Laitance: A thin, weak, brittle layer of cement and aggregate fines on a concrete surface.
   24. Mil: 0.001 inch.
   25. Overspray: Dry spray, particularly paint bonded to an unintended surface.
   26. Pinhole: A small diameter discontinuity in a coating or coating system film, created by offgassing from a void in a concrete or masonry substrate causing

a void between coats or exposing the substrate. Usually caused by coating application while temperature is rising.

27. Pot Life: Time interval after components are mixed and coating can be satisfactorily applied.
28. Prime Coat: First full paint coat applied to a surface when using a multicoat system. Primers adhere to a new substrate, protect the substrate, and promote adhesion of subsequent coats of paint. The prime coat on metal surfaces is the first full coat and does not include solvent wash, grease emulsifiers, or other pretreatment applications.
29. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-based material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
30. Shelf Life: Maximum storage time a material may be stored without losing its usefulness.
31. Shop Coat: 1 or more coats applied in an off-site shop or plant before shipment to work site where field or finishing coat(s) are applied.
32. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
33. Stripe Coat: A separate brush coat of paint applied to all weld seams, pits, nuts/bolts/washers, and edges. This coat shall not be applied until previous coats have cured. Once applied, the coat shall be allowed to cure before subsequent coats are applied.
34. System: Protective film with 1 or more coats applied in a predetermined order, including surface preparation and quality control requirements.
35. Thick Film Coating System: A coating system applied with a minimum dry film thickness of 25 mils.
36. Tie Coat: An intermediate coat that bonds different types of paint material, improving succeeding coat adhesion.
37. Touch-Up Painting: Application of paint on previously painted surfaces to repair marks, scratches, and deteriorated or damaged areas to restore the appearance and performance of the coating.
38. Water Blast: An alternative to air abrasive blast cleaning that can be used with or without abrasive injection. Water cleaning at pressures up to 5,000 pounds per square inch is called low-pressure water cleaning or power washing. High-pressure water cleaning uses water pressures between 5,000 and 10,000 pounds per square inch. Water jetting is water blasting with added abrasive at pressures between 10,000 and 25,000 pounds per square inch. Ultra-high-pressure water jetting is water blasting at pressures above 25,000 pounds per square inch.
39. Weld Splatter: Beads of non-structural weld metal that adhere to the surrounding surface, removed as part of surface preparation.

1.04 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures, submit the following:
   1. Schedule of proposed coating materials.
   2. Schedule of surfaces to be coated with each coating material.
   3. Dehumidification and heating plan.
   4. Product data:
      a. Physical properties of coatings, including the following:
         1) Solids content.
         2) Ingredient analysis.

3) VOC content.
4) Temperature resistance.
5) Typical exposures and limitations.
6) Manufacturer's standard color chips.

b. Compliance with regulatory requirements:
1) VOC limitations.
2) Lead compounds and polychlorinated biphenyls.
3) Abrasives and abrasive blast cleaning techniques and disposal.
4) Methods for tenting blasting areas and methods to protect existing equipment from dust and debris.
5) NSF certification of coatings for potable water supply systems.

c. CSM's current printed recommendations and product datasheets for coating systems, including:
1) Surface preparation recommendations.
2) Primer type.
3) Maximum dry and wet-mil thickness per coat and number of coats.
a) Coating coverage worksheets.
4) Minimum and maximum curing time between coats, including atmospheric conditions for each.
5) Curing time before submergence in liquid.
6) Thinner to be used for each coating.
7) Ventilation requirements.
8) Minimum and maximum atmospheric conditions during which the paint shall be applied.
9) Allowable application methods.
10) Maximum allowable substrate moisture content.
11) Maximum shelf life.
12) Requirements for transportation and storage.
13) Mixing instructions.
14) Shelf life.
15) Material Pot life.
16) Precautions for applications free of defects.
17) Method of application.
18) Drying time of each coat, including prime coat.
19) Compatible prime coats.
20) Limits of ambient conditions during and after application.
21) Required protection from sun, wind, and other conditions.
22) Touch-up requirements and limitations.
23) Minimum adhesion of each system submitted in accordance with ASTM D4541 and ASTM D7234.

d. Samples: Include 8-inch square drawdowns or brushouts of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.

e. Affidavits signed by an officer of the CSM’s corporation attesting to full compliance of each coating system component with current federal, state, and local air pollution control regulations and requirements.

f. List of cleaning and thinner solutions allowed by the CSMs.

g. Storage requirements, including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.

h. Thick film coating systems (greater than 25 mils):
    1) CSM's detailed written instructions for coating system treatment and graphic details for coating system terminations in coated structures, including pipe penetrations, metal embedments, gate frames, and other terminations encountered.
    2) Include detail treatment for coating system at concrete joints.
    3) Manufacturer's Representative's (CTR) Field Reports.

5. Quality assurance Submittals:
    a. Quality assurance plan.
    b. Qualifications of CSA, including:
        1) List of Similar Projects.
            a) Name and address of project.
            b) Year of installation.
            c) Year placed in operation.
            d) Point of contact: Name and phone number.
        2) Provide a minimum of 5 project references, each including contact name, address, and telephone number where similar coating work has been performed by their company in the past 5 years.
    c. CSA Reports:
        1) Written daily quality control inspection reports.
    d. CTR Reports:
        1) Reports on visits to project site to view and approve surface preparation of structures to be coated.
        2) Reports on visits to project site to observe and approve coating application procedures.
        3) Reports on visits to coating plants to observe and approve surface preparation and coating application on shop-coated items.

1.05 QUALITY ASSURANCE

A. CSA qualifications:
    1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
        a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 5 years.
    2. SSPC-QP 1 certified.
    3. Manufacturer-approved applicator when manufacturer has approved applicator program or when required in these specifications.

B. CTR qualifications:
    1. Certification, one of the following:
        a. NACE Level 2 or 3 Certified Coating Inspector.
        b. SSPC Level 3 Protective Coatings Inspector.
    2. Minimum of 5 years of experience evaluating application of manufacturer's coatings under conditions similar to those of the Work:
        a. Provide CTR qualifications and references listing 5 similar projects completed in the past 5 years.

C. Regulatory requirements: Comply with governing agencies' regulations by using coatings in accordance with to their VOC limits.
    1. Lead-based coatings are not permitted.

2. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.

D. Certification:
   1. Certify that applicable pigments resist deterioration when exposed to hydrogen sulfide and other sewage gases.
   2. Product data shall designate coating as being suitable for wastewater service.

E. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.
   1. Coordinate Hold Point schedule.

F. Field samples:
   1. Prepare and coat a minimum 100-square-foot area of each system between corners or limits such as control or construction joints.
   2. Approved field sample may be part of the Work.

G. Obtain approval before coating other surfaces. Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

H. CSM services:
   1. CSA shall arrange for CTR to attend pre-installation conferences.
   2. Visit the project site periodically to consult on and inspect specified surface preparation and application Hold Points.
   3. Visit coating plants to observe and approve surface preparation procedures and coating application of items to be shop primed and coated.
   4. CTR shall provide written inspection reports.

I. Quality control requirements:
   1. Contractor shall be responsible for the workmanship and quality of the coating system installation.
      a. Inspections by Owner, Engineer, CSA, or CTR will not relieve or limit Contractor’s responsibilities.
   2. In accordance with this specification's requirements and the standards referenced in this Section. Changes in the coating system application requirements will be allowed only with the Engineer's written acceptance.
   3. Specially trained crews with experience applying the specified coating system coating are required for:
      a. Coating application using plural component spray equipment or other specialty equipment.
      b. Coating with specialty linings for severe service conditions, including floor coatings, and with linings for corrosive headspaces or secondary containment areas.
   4. CTR shall specially train personnel for coating systems as specified in Attachment B - Coating Detail Sheets.
      a. CSM shall approve personnel in writing applying the coating system.
   5. Do not use contaminated, outdated, diluted materials, and/or materials from previously opened containers.
   6. Identify inspection access points used by Owner's or Engineer's personnel.

7. Provide ventilation, ingress, egress, or other means as necessary for Owner's or Engineer's personnel to safely access the work areas.
8. Conduct and continually inspect work so the coating system is installed as specified. CSM shall provide written directions to correct coating work not in accordance with the specifications or is otherwise unacceptable.
9. Provide written daily reports summarizing test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system application.
    a. Determine relative humidity in accordance with ASTM E337. Confirm other conditions, such as proper protective measures for surfaces not to be coated and safety requirements for personnel.
        1) Measure daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
        2) Determine the acceptability of weather and/or environmental conditions within the structure in accordance with the CSM's requirements.
    b. Monitoring surface preparation: Spot check cleanliness, surface profile, and surface pH testing at least 3 times daily. Check each surface at least once. In accordance with:
        1) ASTM D4262.
        2) ASTM D4263.
        3) ASTM D4417.
        4) ICRI 310.2 requirements.
        5) SSPC Surface Preparation Standards.
    c. Confirm that compressed air used for surface preparation or blow-down cleaning is free of oil and moisture.
    d. Monitor surface preparation daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
    e. Do not apply coatings when environmental conditions are outside of the CSM's published limits.
    f. Monitoring coatings application: Continuously inspect, measure, and record the wet film thickness and general film quality (visual inspection) for runs, sags, pinholes, holidays, etc., during coating.
        1) Perform WFT measurements in accordance with ASTM D4414.
    g. Post cure evaluation: Measure and inspect the overall dry film thickness on all surfaces.
        1) Conduct a DFT survey and perform adhesion testing, holiday detection, or cure testing as required in this Section and/or the CSM's written instructions.
        2) Perform applicable tests in accordance with ASTM D4541, ASTM D4787, ASTM D5162, ASTM D7234, SSPC-PA 1, SSPC-PA 2, SSPC-PA 9, and other pertinent standards and recommended practices.

J. Inspection at Hold Points:
    1. Conduct inspections at Hold Points during the coating system application and record the results.
    2. Coordinate Hold Points with the Engineer so the Engineer can observe Contractor's inspections on a scheduled basis.
    3. Provide the Engineer a minimum of 24 hours of notice before conducting Hold Point Inspections.

4. Hold Points shall be as follows:
    a. Conditions before surface preparation: Before starting surface preparation, observe, record, and confirm that oil, grease, and/or soluble salts are gone from the surface.
    b. Post surface preparation: After completing surface preparation, measure and inspect for cleanliness and proper surface profile as specified in this Section and in the CSM's written instructions.
    c. Coatings application: At the beginning of any coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
    d. Post application inspection: Identify defects in application work on all surfaces, including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness, and other problems.
    e. Follow-up corrective actions and final inspection: Measure and re-inspect corrective coating work performed to repair defects at prior Hold Points and repeat until the surface condition is acceptable. Conduct final visual inspection with follow-up tests, such as holiday detection, adhesion tests, and DFT surveys.
    f. Coatings application: At the beginning of coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
        1) Observe conditions during the pre-application meeting.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as specified in Section 01600 - Product Requirements.

B. Immediately remove unspecified and unapproved coatings from Project site.

C. Deliver new labeled, unopened containers:
    1. Do not deliver materials after manufacturer's expiration date or over 12 months from manufacturing date, whichever is more stringent. Store materials in well-ventilated enclosed structures and protect from weather and excessive heat or cold in accordance with the CSM's recommendations.
        a. Store flammable materials in accordance with federal, state, and local requirements.
        b. Store rags and cleanup materials appropriately to prevent fire and spontaneous combustion.
    2. Store and dispose of hazardous waste in accordance with federal, state, and local requirements. This requirement specifically applies to waste solvents and coatings.
    3. Container labels shall show the following:
        a. Brand name or product title.
        b. CSM's batch number.
        c. CSM's manufacture date.
        d. CSM's name.
        e. Generic material type.
        f. Application and mixing instructions.

g. Hazardous material identification label.
h. Shelf life expiration date.
i. Color.
j. Mixing and reducing instructions.

4. Clearly mark containers to indicate safety hazards associated with the use of or exposure to materials.

1.07 PROJECT CONDITIONS

A. Apply coatings to dry surfaces.
1. Surface moisture: Comply with manufacturer's requirements or as specified in this Section.
a. Plaster and gypsum wallboard: 12 percent.
b. Masonry and concrete block: 12 percent.
c. Interior located wood: 15 percent.
d. Concrete floors: Moisture vapor transmission rate of no more than 3.0 pounds per 1,000 square feet per 24 hours in accordance with ASTM F1869 or relative humidity no greater than 80 percent if tested in accordance with ASTM F2170 unless the CSM's recommendations are more restrictive.
e. Concrete structures: Negative results from Plastic Sheet Test in accordance with ASTM D4263, and maximum of 80 percent relative humidity in accordance with ASTM F2170.

B. Do not apply coatings when the following conditions exist. If such conditions exist, provide containment, covers, environmental controls, and other necessary measures.
1. During rainy, misty, or damp weather, or to surfaces with frost or condensation.
2. When the surface temperature is below 10 degrees Fahrenheit above the dew point.
3. When ambient or surface temperature:
a. Is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
b. Is less than 65 degrees Fahrenheit for clear finishes unless manufacturer allows a lower temperature.
c. Exceeds 90 degrees Fahrenheit unless manufacturer allows a higher temperature.
d. Exceeds manufacturer's recommendation.
4. When relative humidity is higher than 85 percent.
5. Under dusty or adverse environmental conditions.
6. When light on surfaces measures less than 15 foot-candles.
7. When wind speed exceeds 15 miles per hour.

C. Apply coating only under evaporation conditions rather than condensation.
1. Use dehumidification equipment, fans, and/or heaters inside enclosed areas to maintain required atmospheric and surface temperature requirements for proper coating application and cure.
2. Measure and record relative humidity and air and surface temperatures at the start and end of each shift to confirm proper humidity and temperature levels inside the work area.
a. Submit test results.

D. Continuously ventilate, dehumidify, and heat enclosed spaces with high humidity during surface preparation, coating application, and curing.
   1. Maintain minimum air temperature of 55 degrees Fahrenheit and 10 degrees Fahrenheit above the dew point.
   2. Maintain dew point of at least 10 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is performed.
   3. Reduce dew point temperature in conditioned space by at least 10 degrees Fahrenheit within 20 minutes.
   4. Seal work areas and maintain positive pressure per dehumidification equipment supplier's recommendations.
   5. Maintain these conditions before, during, and after application to ensure proper adhesion and cure of coatings for no less than:
      a. Entire curing period.
      b. 8 hours after coating.

E. Systems:
   1. Site electrical power availability as specified in Section 01500 - Temporary Facilities and Controls.
   2. Internal combustion engine generators may be used.
      a. Obtain required permits and provide air pollution and noise control devices on equipment as required by permitting agencies require.
      b. Comply with state, federal, and local fire and explosion protection measures when locating and operating generator.
      c. Locate engine generator outside hazardous classified areas in accordance with NFPA 820.
      d. Provide daily fuel service for generator for duration of use.
   3. Dehumidification:
      a. Provide desiccant or refrigeration drying.
      b. Use only desiccant types with a rotary desiccant wheel capable of continuous operation.
      c. Liquid, granular, or loose lithium chloride drying systems are not acceptable.
   4. Heating:
      a. Use electric, indirect combustion, or steam coil.
      b. Direct-fired combustion heaters are not acceptable heat sources during abrasive blasting, coating application, or coating cure.
   5. Filters:
      a. Use a filtration system for dust removal designed to not interfere with dehumidification equipment’s ability to control dew point and relative humidity inside the reservoir.
      b. Do not allow air from the working area or dust filtration equipment to recirculate through thein dehumidifier during coating application or when solvent vapors are present.
   6. Design and Submittals:
      a. Prepare and submit dehumidification and heating plan, including all equipment and operating procedures.
      b. Suppliers of services and equipment shall have at least 3 years of experience in similar applications.

F. Provide containment and ventilation system components in accordance with SSPC-Guide 6, Level 3 and as required for hazardous materials.

1.08 MAINTENANCE

A. Provide table of products applied organized by surface type. List coating manufacturer, color, color formulation, distributor name, telephone number, and address.

B. Provide extra materials:
   1. Minimum 1 gallon of each type and color of coating applied or provide additional quantities if specified in the Contract Documents:
      a. Deliver unopened factory-labeled cans when manufacturer packages material in gallon cans.
      b. Deliver material in new gallon containers, properly sealed and identified with permanently affixed, durable, printed labels indicating brand, type, and color, when manufacturer does not package material in gallon cans, deliver.

1.09 CTR RESPONSIBILITIES

A. General:
   1. Attend pre-installation conference.
   2. Perform onsite application training.
   3. Periodically inspect coating system application.

B. Coating system installation training:
   1. Provide a minimum of 8 hours of classroom and off-site training for application personnel and supervisory personnel in one of the following ways:
      a. Train a minimum of 2 supervisory personnel and 2 application personnel.
      b. Submit a letter from the CSM stating that CSM approves the supervisory and application personnel, listed by name and responsibility, and no additional training is required.
   2. CTR can train up to 14 application personnel and 3 supervisory personnel at a time.
   3. Minimum training requirements:
      a. Explain in detail the mixing, application, curing, and termination requirements.
      b. Provide hands-on demonstration of coating system mixing.
      c. Explain in detail the ambient condition requirements for temperature and humidity.
      d. Explain in detail the surface preparation requirements.
      e. Explain in detail the re-coat times, cure times, and related ambient condition requirements.
      f. Write a letter stating that training was satisfactorily completed by the personnel, listed by name and responsibility.
   4. Provide special training as specified in the Coating Detail Sheets.

C. Coating system inspection:
   1. CTR inspection is in addition to the CSA's inspection as specified in this Section.
   2. Be on-site to oversee:
      a. Coating application at least once a week.
      b. End of surface preparation.
      c. During coating application.

d. Post-cure inspection.

3. Routinely inspect and verify in writing that application personnel have successfully performed surface preparation, filler/surfacer application, coating system application, and Quality Control Inspection in accordance with this Section and to warrantable quality.
4. Perform the following activities to confirm conformance with the specifications:
   a. Inspect ambient conditions during coating system installation at Hold Points for conformance with the specified requirements.
   b. Inspect each coated surface type and coating system applied to verify the following:
      1) Cleanliness.
      2) Surface pH for concrete substrates.
      3) Confirm surface preparation of substrates where coating system will terminate or will be applied for conformance to the specified application criteria.
   c. Verify surface profile of substrates by completing the following:
      1) Inspect preparation and application of coating detail treatment at terminations, transitions, metal embedments in concrete, and joints and cracks in substrates.
      2) Inspect application of filler/surfacer materials for concrete and masonry substrates.
      3) Verify proper mixing of coating materials.
      4) Inspect application of primers and finish coats, including wet and dry film thickness.
      5) Inspect coating systems for proper cure times and conditions.
   d. Review adhesion testing of cured coating systems.
   e. Review coating system continuity testing.
   f. Inspect and record representative-localized repairs.
   g. Conduct final review of completed coating system installation.
   h. Prepare and submit site visit reports after each site visit to document that the coating work is in accordance with the CSM's Recommendations.

D. Final report:
   1. Prepare a final report, after coating work ends, summarizing each day's test data, observations, drawings, and photographs.
      a. Include substrate conditions, ambient conditions, and application procedures observed during the CTR's site visits.
      b. Include a statement that completed work was performed in accordance with the requirements of the CSM's recommendations.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

A. Coating materials shall be formulated for environments encountered in water and wastewater treatment processes.

B. Coating materials that come in contact with water distributed as potable water shall be certified in accordance with NSF 61.

2.02 MATERIALS

A. General:
   1. Product requirements: As specified in Section 01600 - Product Requirements.

2.03 COATING SYSTEMS IDENTIFICATION

A. Naming conventions: Coating Systems Identifications contain the elements defined in Table 1.

Table 1. Coating System Identification Elements

First Element	**-**	**Second Element**	**-**	**Third Element**	**-**	**Fourth Element (optional)**
3 or 4 alpha characters		1-3 alpha characters		1 number		3 or 4 alpha characters
Coating Type		Substrate		System Number		Additional Substrate or Special Condition
Example: EPX	-	C	-	6	-	BSC

1. First element identifies the coating type using the following abbreviations:
   a. ACR: Acrylic.
   b. CTE: Coal tar epoxy.
   c. ELA: Elastomeric acrylic.
   d. EPU: Epoxy-polyurethane.
   e. EPX: Epoxy.
   f. POL: Polyurethane.
   g. SIL: Silicone.
   h. SILX: Siloxane or silane.
   i. VE: Vinyl ester.
2. Second element identifies the substrate using the following abbreviations:
   a. C: Concrete or masonry.
   b. F: Concrete flooring.
   c. FRP: Fiber-reinforced plastic.
   d. GM: Galvanized metal.
   e. M: Metal.
   f. PVC: Polyvinyl chloride, chlorinated polyvinyl chloride.
3. Third element identifies the sequential system number.
   a. For example, EPX-C-2 is the second standard epoxy coating system for concrete substrates.
4. Fourth element is optional and identifies the additional substrate or special condition with the following abbreviations:
   a. PWS: Potable water service applications (NSF-61 approved).
   b. BSC: Biogenic sulfide corrosion-resistant applications in wastewater.
   c. BG: Below grade or buried.
   d. OZ: Organic zinc primer, epoxy polyurethane system.
   e. SC: Secondary containment.

2.04 PRODUCTS FOR COATING SYSTEMS

A. Products: As specified in Attachment B - Coating Detail Sheets.

B. Cleaning solvents:
   1. Requirements for solvent wash, solvent wipe, or cleaner used, including, but not limited to, those used for surface preparation in accordance with SSPC-SP 1:
      a. Emulsifying type.
      b. Containing no phosphates.
      c. Biodegradable.
      d. Does not damage zinc.
      e. Compatible with the specified primer.
      f. Complying with applicable air-quality control board requirements.
   2. Use clean white cloths and clean fluids in solvent cleaning.

PART 3 EXECUTION

3.01 GENERAL PROTECTION REQUIREMENTS

A. Protect adjacent coated surfaces from coatings and damage associated with coating work. Repair damage resulting from inadequate or unsuitable protection.

B. Use drop cloths and other coverings to protect adjacent surfaces not to be coated against spatter and droppings.

C. Mask off surfaces of items not to be coated or remove items from area.

D. Furnish and deploy sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.

E. Place coating waste, cloths, and material that may pose a fire hazard in closed metal containers and remove daily from site.

F. Remove electrical plates, surface hardware, fittings, and fasteners before coating application.
   1. Carefully store, clean, and replace items after completing coating in each area.
   2. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finishes.

G. Erect and maintain protective enclosures in accordance with SSPC-Guide 6.

H. Protect the following surfaces from abrasive blasting by masking or by other means:
   1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting where sprockets will be fit.
   5. Surfaces of shafting where bearings will be fit.
   6. Machined bronze surfaces, including slide gates.
   7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used to assemble equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

I. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by spent abrasive blast media, dust, or dirt entering such equipment.

J. Schedule cleaning and coating to keep dust and spray from the cleaning process from falling on wet, newly coated surfaces.
   1. Whenever possible, coordinate with other trades and complete surface preparation and coating work before installing hardware, hardware accessories, nameplates, data tags, electrical fixtures, and similar uncoated items that will be in contact with coated surfaces. Mask machined surfaces, sprinkler heads, and other small items that will not be coated.
   2. After completing coating, reinstall removed items.
   3. Disconnect and move equipment adjacent to walls to clean and coat equipment and walls. Replace and reconnect equipment after coating.

3.02 GENERAL SURFACE PREPARATION REQUIREMENTS

A. Prepare surfaces in accordance with CSM's instructions unless more stringent requirements are specified in this Section.

B. Coating detail sheets in Attachment B - Coating Detail Sheets include additional surface preparation requirements.

C. Follow more stringent requirement if information conflicts.

D. Where required by the Owner’s representative, a NACE International certified coatings inspector, provided by the Owner will inspect and approve surfaces to be coated before applying a coating.
   1. CSA shall coordinate coating inspections.
      a. Identify coating inspection Hold Points during the pre-installation conference.
      b. Provide at least 2 days' notice before inspection.
   2. Correct surface defects identified by the inspector at no additional cost to the Owner.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

A. Identify equipment, ducting, piping, and conduit as specified in Section 15050 - Common Work Results for Mechanical Equipment, Section 15076 - Pipe Identification, and Section 16075 - Identification for Electrical Systems.

B. Remove grilles, covers, and access panels for mechanical and electrical system and coat separately.

C. Prepare and finish coat equipment primed by the manufacturer using specified intermediate and top coats, as applicable, and color selected by the Owner.

D. Prepare, prime, and coat both insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with material not requiring coating, or with a prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

F. Prepare and coat interior surfaces of air ducts and convector and baseboard heating cabinets visible through grilles and louvers with 1 coat of flat black paint to limit of sight line.

G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convector and baseboard heating cabinets to match face panels.

H. Prepare and coat exposed conduit and appurtenances occurring in finished areas with color and texture to match adjacent surfaces.

I. Prepare and coat sides' front, back, and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

3.04 CLEANING OF NEW AND PREVIOUSLY COATED OR NEW SURFACES

A. Utilize cleaning agent to remove soluble salts, such as chlorides, from concrete and metal surfaces:
   1. Cleaning agent: Biodegradable non-flammable and containing no VOC.
   2. Manufacturers: The following or equal:
      a. CHLOR*RID International, Inc.
         1) Complete soluble salt removal with steam or warm water cleaning.
   3. Steam clean and degrease surfaces to be coated to remove oils and grease.
   4. Clean surfaces with decontamination agent in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing, as approved by the CTR and the Engineer.
   5. Test cleaned surfaces to ensure removal of soluble salts. Carry out additional cleaning as needed.
   6. Complete final surface preparation before applying new coating system in strict accordance with CSM's printed instructions.

3.05 BLAST CLEANING

A. Surface preparation requirements:
   1. Do not reuse spent blast abrasive.
   2. Ensure that filter compressed air used for blast cleaning is free of condensed water and oil.
      a. Clean moisture traps at least once every 4 hours or more frequently, as required, to prevent moisture from entering the abrasive blasting equipment air supply.
      b. Check blast air for moisture and oil after each cleaning in accordance with ASTM D4285.
   3. Install oil separators just downstream of compressor discharge valves and at the discharge point of blast pot discharges. Check separators on the same frequency as the moisture traps.

4. Keep regulators, gauges, filters, and separators on compressor air lines to blasting nozzles operational at all times.
5. Install an air dryer or desiccant filter drying unit to dry the compressed air before blast pot connections. Use and maintain the dryer throughout surface preparation work.
6. Use a venturi-type, or other high velocity-type, abrasive blast nozzles supplied with at least 100 pounds per square inch gauge air pressure at the nozzle and enough volume to obtain appropriate blast cleaning production rates and surface cleanliness.
7. Provide airborne particulate evacuation and filtering that meets OSHA safety standards. Maintain optimal visibility both to clean and provide the specified surface profile and to allow inspection of the substrate during surface preparation work.
8. If prepared and cleaned metallic substrates become contaminated between final surface preparation work and coating system application, or if the prepared substrate darkens or changes color, re-clean by water blasting, or abrasive blast cleaning as appropriate until the specified degree of cleanliness is restored.

B. Water jetting or water blasting:
1. Use water jetting or water blasting for recoating or relining where an adequate surface profile exists.
2. Perform water jetting or water blasting in accordance with SSPC-SP 13 and SSPC-WJ-1, WJ-2, WJ-3, WJ-4.

3.06 PREPARATION REQUIREMENTS FOR CONCRETE SURFACES

A. Cure for at least 28 days before coating.

B. Remove degraded concrete using abrasive blast cleaning or high or ultra-high-pressure water jetting, chipping, or other abrading tools until achieving a sound, clean substrate. Remove bruised or cracked concrete.

C. Prepare substrate cracks and areas requiring resurfacing; perform detail treatment, including, but not limited to, terminating edges in accordance with the CSM's recommendations, and as indicated on the Drawings.
1. Prepare concrete surfaces in accordance with SSPC-SP 13.

D. Prepare concrete surfaces in accordance with SSPC-SP 13.
1. Inspect concrete surfaces to select appropriate surface preparation method to provide a suitable substrate for the specified coating system.
2. Use blast cleaning or other means to expose the complete perimeter of air voids or bug holes. Do not leave shelled over, hidden air voids beneath the exposed concrete surface.
3. Repair concrete defects and physical damage.
4. Clean concrete surfaces of dust, mortar, formwork, fins, loose concrete particles, form release materials, oil, and grease.
5. Fill voids to provide surface as specified in Section 03366 - Concrete Finishes.

E. Provide clean substrate visually free of calcium sulfate, loose, coarse, or fine aggregate, laitance, loose hydrated cement paste, and otherwise harmful substances.
   1. Confirm concrete surface minimum pH of 9.0 with surface pH testing.
   2. If after surface preparation the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.

F. Prepare concrete surface for coating in accordance with SSPC-SP 13.
   1. Provide ICRI 310.2 minimum No. 3 concrete surface profile (CSP) or as specified on Coating Detail Sheets.
   2. Evaluate profile of the prepared concrete using ICRI 310.2 surface profile replicas.

G. Blast clean cementitious repair mortars or grouts to the same profile and degree of cleanliness requirements required for concrete substrates.

H. Blast clean polymer-based surfacers or waterborne modified cementitious surfaces only if they have exceeded the CSM's recommended recoat time.

I. Vacuum concrete surfaces before coating application, leaving a dust free, sound concrete substrate.
   1. Thoroughly clean concrete surfaces to be coated to remove loose dirt and spent abrasive.
   2. Remove debris produced by blast cleaning from the structures to be coated, and legally dispose of it off-site.

J. Test moisture content of concrete to be coated:
   1. Conduct ASTM D4263 plastic sheet test at least once for every 500 square feet of surface area to be coated.
      a. Any moisture on plastic sheet after test period constitutes a non-acceptable test, and the concrete must be dried further.
   2. Conduct ASTM F1869 test at least once for every 1,000 square feet of concrete floor surface area to be coated.
   3. Conduct ASTM F2170 one relative humidity moisture test at least once for each 500 square feet of non-floor concrete surface area where the opposite side is exposed to soil or water.
      a. Waterproof surfaces exposed to soil or water where specified in Section 07110 - Dampproofing.
   4. Comply with specified minimum moisture content and CSM’s written recommendations for moisture vapor transmission rates or relative humidity values.

K. Masonry surfaces:
   1. Cure for at least 28 days before coating.
   2. Prepare masonry surfaces to remove chalk, laitance, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
   3. Wash and scrub masonry surfaces with clear water. Do not use muriatic acid.
   4. Seal or fill masonry surfaces with a sealer or block filler compatible with the specified primer after cleaning.

5. Confirm that masonry surfaces are dry before coating application.
    a. If using pressure washing or low-pressure water blast cleaning for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or until the minimum ambient temperature is 70 degrees Fahrenheit before coating.

3.07 GENERAL PREPARATION REQUIREMENTS FOR METALLIC SURFACES

A. Remove rust, scale, and welding slag and spatter.
    1. Remove and grind smooth excessive weld material and weld spatter on metal surfaces before blast cleaning in accordance with NACE SP0178, Appendix C, Level C.
    2. Grind sharp edges on metal substrate to approximately 1/16-inch radius before abrasive blast cleaning.

B. Prepare metallic surfaces in accordance with applicable portions of surface preparation specifications of the SSPC specified for each coating system.
    1. Remove grease and oil in accordance with SSPC-SP 1.
    2. Use solvent as recommended by the CSM.
    3. Measure profile depth of the surface to be coated in accordance with Method C of ASTM D4417. Select blast particle size and gradation to produce the specified surface profile.
    4. Constantly monitor and maintain ambient environmental conditions to ensure cleanliness and that no “rust back” occurs before coating material application.

C. Prepare metallic surfaces by blast cleaning in accordance with SSPC-VIS 1 (ASTM D2200). Prepare abrasive blast representative areas for the Owner's representative to inspect on the first day of cleaning.

D. Unless otherwise specified, the requirements for blast cleaning steel, ductile iron, and stainless steel substrates are as follows:
    1. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC-SP 10 unless blasting may damage adjacent surfaces, is prohibited, or is specified otherwise. Where abrasive blasting is not possible, clean surfaces to bare metal with power tools in accordance with SSPC-SP 11.
    2. Ferrous metal surfaces to be submerged: Abrasive blast in accordance with SSPC-SP 5, unless specified otherwise, to clean and provide roughened surface profile with a depth between 2 and 4 mils.
    3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products, or embedded abrasive from substrate before coating application.
    4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast clean surfaces again.

E. Field preparation of shop-primed surfaces:
    1. Smooth welds and prominences with power tools before applying field-applied coatings.
    2. Clean and dry shop-primed ferrous metal surfaces and fabricated assemblies before applying field coats.

3. Prepare shop epoxy primed surfaces with light abrasive blasting or abrading and then vacuum before applying finish coats.
    a. Follow CSM instructions for surface preparation when the primer recoat limit has been exceeded.
4. Non-immersion service: Clean in accordance with SSPC-SP 2 (Hand Tool Cleaning) or SSPC-SP 3 (Power Tool Cleaning) and uniformly roughen.
5. Immersion, BSC, and SC service: Remove shop primer in accordance with SSPC-SP 5 (Near-White Blast Cleaning).

F. Damaged shop primer or rust bleeding:
1. Ferrous metals: Clean in accordance with SSPC-SP 1 (Solvent Cleaning) and spot blast in accordance with SSPC-SP 10 (Near-White Metal Blast Cleaning) to achieve a uniform surface profile between 2.0 and 2.5 mils before recoating.
2. Reject galvanized steel with rust bleeding.

G. Damaged coating: Repair by abrasive blast cleaning surfaces as specified for the coating system; feather to a smooth transition before touching up.

3.08 PREPARATION REQUIREMENTS BY SURFACE TYPE

A. Galvanized steel and non-ferrous metal surfaces:
1. Degrease or solvent clean (SSPC-SP 1) to remove oily residue.
2. Abrasive blast clean in accordance with SSPC-SP 16.
    a. If abrasive blast cannot be performed, abrade in accordance with SSPC-SP 3 (Power Tool Cleaning).
3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded, such as bolts, nuts, or preformed channels.
4. Test surface for contaminants using copper sulfate solution.

B. Stainless-steel surfaces:
1. Abrasive blast clean in accordance with SSPC-SP 16 to leave a clean, uniform appearance with surface profile between 1.5 and 2.5 mils.

C. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.

D. Sherardized, aluminum, copper, and bronze surfaces:
1. Abrasive blast clean in accordance with SSPC-SP 16.
2. Prepare in accordance with CSM's instructions.

E. Cadmium-plated, zinc-plated, or sherardized fasteners:
1. Abrasive blast in the same manner as uncoated metal when assembling equipment designated for abrasive blasting.

F. PVC and FRP surfaces:
1. Lightly sand surfaces to be coated.
    a. Sand to remove gloss and establish uniform surface profile.
2. Vacuum to remove loose dust, dirt, and other materials.
3. Solvent clean with clean white rags and allow solvent to evaporate completely before applying coating materials.

3.09 APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Empty aboveground piping to be coated of contents when applying coatings.

C. Mechanical equipment shop primed by the manufacturer.
   1. Pumps and valves: Shop coat with manufacturer's highest quality coating system meeting the project specifications.
      a. Provide CTR shop coating reports.
   2. Non-immersed equipment: Touch up shop primer, and coat in the field with specified coating system after installation.
      a. If project requires equipment removal and reinstallation, complete touch-up coating after final installation.
   3. Immersed equipment not shop coated: Remove shop primer before surface preparation and field apply coating.

D. Verify surface preparation immediately before applying coating in accordance with SSPC-SP COM and the SSPC visual standard for the specified surface preparation method.

E. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

F. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

G. Do not apply coatings to a surface until it has been prepared as specified.

H. Use equipment designed to apply materials specified.
   1. Use compressors with moisture traps and filters that remove water and oils from the air.
      a. Perform a paper blotter test at the Engineer's request to verify air is sufficiently free of oil and moisture. Do not allow the amount of oil and moisture to exceed CSM-recommended amount.
   2. Equip spray equipment with properly sized mechanical agitators, pressure gauges, pressure regulators, and spray nozzles.

I. Where 2 or more coats are required, tint prime coat intermediate coats as necessary to distinguish each coating and to help indicate coverage.
   1. Do not use color additives with chromium, lead or lead compounds that hydrogen sulfide, other corrosive gases, might destroy or alter. Apply the specified number of coats.

J. Apply coating by brush, roller, trowel, or spray unless a specific application method is required by coating manufacturer's instructions or these Specifications.
   1. Apply primer or first coat by brush to power tool cleaned ferrous surfaces.
   2. Brush or spray-apply coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces.
   3. After prime coat dries, mark, repair, and retest pinholes and holidays before intermediate or top coats are applied.

K. Spray application:
   1. With a brush, stripe coat edges, welds, corners, nuts, bolts, and difficult-to-reach areas, as necessary, before spray application to ensure specified coating thickness along edges.
   2. When using spray application, apply each coat to thickness no greater than recommended in coating manufacturer's instructions.
   3. Use airless spray method unless air spray method is required by CSM's instruction or these Specifications.
   4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

L. Lightly sand and thoroughly clean surfaces to receive high-gloss finishes unless CSM instructs otherwise.

M. Remove dust on coatings between coats.

N. Shop and field coats:
   1. Prime coat: Shop-apply or field-apply prime coats as specified. Use shop-applied primer compatible with the specified field coating system and apply at the minimum dry film thickness recommended by the finish coat CSM.
      a. Provide datasheets identifying the shop primer to on-site coating application personnel.
      b. Perform adhesion tests on the shop primer.
      c. Remove and recoat damaged, deteriorated, and poorly applied shop coatings.
      d. If shop primer coat meets this Section's requirements, spot prime exposed metal of shop-primed surfaces before spray applying primer over the entire surface.
   2. Field coats: Apply field coats with 1 or more prime coats and finish coats to build up coating to dry film thickness specified for the coating system.
      a. Do not apply finish coats until other work in the area is complete and previous coats are inspected.
   3. Adhesion confirmation: Perform adhesion tests after proper coating cure in accordance with ASTM D3359. Demonstrate that:
      a. Prime coat adheres to the substrate.
      b. Coatings adhere to the prime and intermediate coats.
         1) Coating 5 mils or more DFT: Achieve adhesion test result of 5A on immersed surfaces and 4A or better on other surfaces.
         2) Coating less than 5 mils DFT: Achieve adhesion test results of 5B on immersed surfaces and 4B or better on other surfaces.

O. Brush, roll, trowel, or spray and back roll coats for concrete and masonry.

P. Plural component coating application:
   1. Premix contents of component drums if required by the CSM each day.
   2. Before starting application:
      a. Verify gauges are working properly.
      b. Complete ratio checks.
      c. Sample the mix on plastic sheeting to ensure set time is appropriate and complete.
      d. Label and retain spray samples. Submit to Engineer when requested.

Q. Drying and recoating:
   1. Provide fans, heating devices, or other means to prevent condensate or dew on substrate surface or between coats and during curing after applying the last coat.
   2. Allow each coat to cure or dry thoroughly, in accordance with if required in CSM's printed instructions, before recoating.
   3. Use CSM's printed instructions and the requirements specified in this Section to determine minimum required drying time.
      a. Do not allow excessive drying time or exposure, which may impair bond between coats.
      b. Recoat coatings within time limits recommended by CSM.
      c. If time limits are exceeded, abrasive blast clean and de-gloss clean before applying another coat.
   4. If limitations on time between abrasive blasting and coating are not met before attaching components to surfaces that cannot be abrasive blasted, coat components before attachment.
   5. Ensure primer and intermediate coats of coating are unscarred and completely integral when applying each succeeding coat.
   6. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
   7. Leave no holidays. Repair holidays in accordance with the requirements on pertinent Coating Detail Sheets or as recommended by the CSM.
   8. Sand and feather into a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so repairs are invisible to the naked eye.
   9. For submerged service or highly corrosive headspace service, provide a letter to the Engineer stating that the lining system is fully cured and ready to be placed into service.

R. Workmanship:
   1. Ensure that coated surfaces are free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce a smooth, even film of uniform thickness completely coating corners and crevices.
   2. Coat surfaces without drops, overspray, dry spray, excessive runs, ridges, waves, holidays, laps, or brush marks.
   3. Remove splatter and droppings after coating work is completed.
   4. Evenly apply each coat of material and sharply cut to a line created with masking tape or other suitable materials.
   5. Avoid over spraying or spattering paint on surfaces not to be coated. Protect glass, hardware, floors, roofs, vehicles, and other adjacent areas and installations by taping, drop cloths, or other suitable measures.
   6. When coating complex steel shapes, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer before overall coating system application.
      a. Brush apply stripe coat to ensure proper coverage.
      b. Do not stripe coat with spray or roller.
   7. Ensure that finish coat, including repairs, has a uniform color and gloss.

S. Coating properties, mixing, and thinning:
   1. Thin prime coat and apply as recommended by the CSM. Thinned coating must comply with prevailing air pollution control regulations.

2. If maximum recoat time is exceeded, prepare surface with solvent washing, light abrasive blasting, or other procedures in accordance with CSM's instructions.
3. Allow adequate drying time between coats as instructed by the CSM, adjusted as necessary for the site conditions.
4. Ensure that coatings, when applied, provide a satisfactory film and a smooth even surface. Lightly sand glossy undercoats to provide a surface suitable for proper application and adhesion of subsequent coats. Thoroughly stir and strain coating materials during application and maintain uniform consistency.
5. Mix coatings with 2 or more components in accordance with CSM's instructions.
6. Where necessary to suit conditions of the surface, temperature, weather, and method of application, thin the coating in accordance with CSM's recommendations.
    a. Ensure that volatile organic content (VOC) of the thinned coating complies with prevailing air pollution control regulations.
    b. Thin coatings to only what is necessary to obtain proper application characteristics.
    c. Use a thinner recommended by the CSM.

T. Film thickness and continuity:
1. Apply coating to the specified thicknesses.
    a. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.
2. Verify WFT of the coating system first coat and after applying each subsequent coat.
3. Do not allow the minimum thickness at any point to deviate more than 25 percent from the required average.
4. Do not allow the surface area covered per gallon of coating for various types of surfaces to exceed those recommended by the CSM.
    a. Provide coating coverage worksheets listing the maximum and minimum coverage for each unit volume of coating for concrete surfaces.
5. Apply additional coats to achieve the specified dry film thickness if brush or roller application methods cannot achieve the specified film thicknesses per coat.

U. Protecting coated surfaces:
1. Do not handle, work on, or otherwise disturb coated items until the coating is completely dry and hard.
2. After installation, recoat shop-coated surfaces with specified coating system as necessary to match surrounding surfaces, and to coordinate with the specified color identification requirements.

V. Special requirements:
1. Before erection, apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces inaccessible after assembly. Apply final coat after erection.
2. Coat structural slip-critical connections and high strength bolts and nuts after erection.
3. Areas damaged during erection:
    a. Prepare surface for spot repairs as specified for the coating system.
    b. Recoat with prime coat before applying subsequent coats.
    c. Touch up surfaces after installation.
    d. Clean and dry surfaces to be coated at time of application.

4. Coat underside of equipment bases and supports not galvanized with at least 2 coats of primer specified before setting the equipment in place.
5. Coat aluminum in contact with concrete.

3.10 APPLICATION REQUIREMENTS FOR CONCRETE COATING SYSTEMS

A. Apply filler/surfacer as recommended by CSM to fill bug holes and air voids in concrete or block texture in CMU, leaving a uniformly filled surface that does not produce blowholes or outgassing causing the coating system to pinhole.
   1. Allow filler/surfacers to cure sufficiently before applying prime coat as required by the CSM. Use the CSM-recommended drying time between coats.

B. Apply surfacer or filler and let dry before coating application.
   1. Use the drying time between filler/surfacer and coating system specified by the CSM for the site conditions.
      a. Let concrete substrate dry before applying filler/surfacers or coating system materials.
   2. If the maximum recoat time is exceeded, prepare surfaces by solvent washing, light abrasive blasting, and other procedures in accordance with CSM's instructions.
   3. Apply a complete parge coat of the specified filler/surfacer material over the entire substrate before applying the coating system.
      a. Scrub filler/surfacer into the substrate to completely fill open air voids and bug holes.
      b. Completely cover the substrate, unless otherwise specified, above such filled voids by 1/8 inch of thickness.
      c. Provide relatively flat, uniformly even surface before coating application.
   4. Secondary containment: Place surfacer or filler 1/16-inch thick above concrete plane to create a monolithic surface free of pinholes.
      a. Floor surfaces: Broadcast with aggregate to create a non-slip surface texture.
      b. Remove excess aggregates and apply base coat to encapsulate embedded non-slip aggregate.

C. Concrete substrate temperatures:
   1. Apply filler/surfacers and the coating system when temperatures are falling, typically late afternoon or evening.
      a. Do not coat concrete with rising concrete substrate surface temperatures or substrates in direct sunlight, to minimize outgassing from the substrate and formation of pinholes, and/or blistering.
   2. Should bubbles, pinholes, or other discontinuities form in the applied coating system material, they shall be repaired.
      a. Should discontinuities develop in the filler/surfacer material or in the first coat of the coating material, repair them before the next coat.
      b. When discontinuities occur, open the air void behind or beneath the discontinuities and completely fill with specified coating material. Then, abrade the coated area around the discontinuities repair reapply coating over that area.

D. Perform application detail work in accordance with these Specifications, the CSM’s current written recommendations, and Drawings, whichever is stricter.

E. Concrete coating systems application requirements:
   1. Concrete coating minimum dry film thickness excludes parge coat, block filler, and sealer.

3.11 COATING SYSTEM SCHEDULE

A. Attachment A - Schedule of Surfaces to be Coated specifies surfaces to be coated in the field with the coating systems required.

3.12 SURFACES NOT REQUIRING COATING

A. Stainless steel piping, valves, pipe supports, instrument sunshades.

B. Sliding surfaces on expansion joints, motor and pump shafts, machined surfaces at bearings and seals, grease fittings, etc.

C. Galvanized structural steel framing, galvanized roof decking, galvanized pipe supports.

D. Copper and brass pipe, fittings, valves, etc.

E. Bronze valves, bearings, bushings, and fasteners.

F. Corrosion resistant special alloys: Inconel, Alloy 20, Hastelloy, etc.

G. Exterior concrete.

H. Plastic surfaces except coat PVC, CPVC, and other plastic piping system exposed to sunlight.

I. Buried piping that is encased in concrete or cement mortar.

3.13 QUALITY CONTROL

A. Owner-provided inspection or inspection by others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Owner inspection is in addition to any inspection required of the Contractor.

B. Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section. These inspections may include the following:
   1. Inspect materials upon receipt to ensure that the CSM supplied them.
   2. Verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
   3. Inspect and record findings for substrate cleanliness.
   4. Inspect and record pH of concrete and metal substrates.
   5. Inspect and record substrate profile (anchor pattern).
   6. Measure and record ambient air and substrate temperature.
   7. Measure and record relative humidity.
   8. Check for substrate moisture in concrete.

9. Verify that mixing of coating system materials is in accordance with CSM's instructions.
10. Inspect, confirm, and record that coating system materials' "pot life" is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
11. Perform adhesion testing.
12. Measure and record the coating system's thickness.
13. Verify proper curing of the coating system in accordance with the CSM's instructions.
14. Holiday or continuity testing in accordance with NACE SP0188 for coatings that will be immersed or exposed to aggressively corrosive conditions.

C. Perform holiday testing in accordance with NACE SP0188 to identify holidays or pinholes needing repair for coating over 100 percent of surfaces:
   1. Coated steel that will be immersed or exposed to aggressively corrosive conditions.
   2. Coated concrete.
   3. Perform holiday tests after proper application and coating system cure.

3.14 CORRECTIVE MEASURES

A. Repair pinholes or holidays identified by Holiday Testing as follows:
   1. Remove the coating system with a grinder or other suitable power tool.
   2. Remove coating system at pinholes and holidays at least 2 inches diameter around the defect back to expose substrate.
   3. Concrete voids: Chip back to expose entire cavity in all directions.
      a. Completely fill void with approved filler/surfacer material using a putty knife or other suitable tool and strike off. Cure in accordance with CSM's recommendations.
   4. Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
   5. Vacuum the prepared area to remove dust, dirt, etc., leaving clean, sound surfaces.
   6. Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
   7. Apply the coating system with enough coats to achieve the specified finish coat thickness over the defect and coating removal area. Feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline.
   8. Follow curing time between coats as specified by CSM for the site conditions. Solvent wash and abrasive blast in accordance with CSM's instructions if the maximum recoat time is exceeded.
   9. Apply coating at specified dry film thickness.

3.15 CLEANUP

A. Remove surplus materials, protective coverings, and accumulated rubbish after completing coating. Thoroughly clean surfaces and repair overspray or other coating-related damage.

3.16 FINAL INSPECTION

A. Conduct final inspection of coating system work to determine whether it meets specifications requirements.

B. Conduct subsequent final inspection with the Engineer to ensure Work is in accordance with Contract Documents requirements.

C. Mark any rework required.
   1. Re-clean and repair, as specified, at no additional cost to the Owner.

END OF SECTION

ATTACHMENT A - SCHEDULE OF SURFACES TO BE COATED

ATTACHMENT A
Schedule of Surfaces to be Coated

A. The following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Contact Engineer for clarification.

EPU-M-1	Metals, exterior, non-immersed
EPX-M-2	Metals, interior, non-immersed
EPX-M-2-PWS	Metals: immersed and in contact with water being treated for domestic use (potable water).
EPX-M-6-BG	0
VE-C-1	0

Notes:

1: Non-immersed ferrous metal surfaces include:
- a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
- b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
- c. Motors and motor accessory equipment.
- d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
- e. Valve and gate operators and stands.
- f. Structural steel.
- g. Crane and hoist rails.
- h. Exterior of tanks and other containment vessels.
- i. Mechanical equipment supports, drive units, and accessories.
- j. Bare electrical equipment: boxes, exposed conduit, and accessories.
- k. Pumps not submerged.
- l. Other miscellaneous metals.

2: Immersed ferrous metal surfaces include:
- a. Interior surfaces of ferrous metal tanks.
- b. Field priming of ferrous metal surfaces with defective shop-prime coat; including non-submerged service.
- c. Bell rings, underside of manhole covers and frames.
- d. Sump pumps, including underside of base plates and submerged suction and discharge piping.
- e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
- f. Submerged pipe supports and hangers.
- g. Stem guides.
- h. Other submerged iron and steel metal unless specified otherwise.

ATTACHMENT B - COATING DETAIL SHEETS

Attachment B			
Coating Detail Sheet			
Coating System	EPU-M-1		
Coating Material	Two coats epoxy with polyurethane finish coat		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carbothane 134 VOC
International Paint	Devran 224V	Devran 224V	Devthane 379
PPG	Amercoat 385	Amercoat 385	Amercoat 450H
Sherwin Williams	Macropoxy 646	Macropoxy 646	Hi Solids Polyurethane
Tnemec	Series 69	Series 69	Series 1095
Service Condition	Interior or Exterior, subject to direct sunlight. Non-immersion.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP10, Near-White Blast Cleaning. Shop primed surfaces: SSPC-SP2, Hand Tool Cleaning or SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP10, Near White Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush Blast Cleaning. Test for surface contaminants.		
Surface Profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	10 to 13 mils		
Primer	4 to 5 mils		
Intermediate Coat	4 to 5 mils		
Finish Coat	2 to 3 mils		
Application			
Special CTR Training	Not required.		

Attachment B			
Coating Detail Sheet			
Coating System	EPX-M-2		
Coating Material	Epoxy		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carboguard 890
International Paint	Bar-Rust 236	Bar-Rust 236	Bar-Rust 236
PPG	Amerlock 2/400 Series	Amerlock 2/400 Series	Amerlock 2/400 Series
Sherwin Williams	Tank Clad HS	Tank Clad HS	Tank Clad HS
Tnemec	Series 69	Series 69	Series 69
Service Condition	Immersed, non-immersed, moderately corrosive environment.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP5, White Metal Blast Cleaning. Shop primed surfaces: SSPC-SP7, Brush-Off Blast Cleaning. Damaged primer or rust: SSPC-SP5, White Metal Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface Profile			
Ferrous Metal	2 to 4 mils		
Nonferrous Metal	1.0 to 1.5 mils		
Galvanized Metal	1.0 to 1.5 mils		
System Thickness (Dry Film)			
Total	12 to 16 mils		
Primer	4 to 6 mils		
Intermediate Coat	4 to 6 mils		
Finish Coat	4 to 6 mils		
Application			
Special CTR Training	Not required.		

Attachment B			
Coating Detail Sheet			
Coating System	EPX-M-2-PWS		
Coating Material	Ultra-high Solids Epoxy		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Plasite 4500	None Applied	Plasite 4500
International Paint	No product specified	No product specified	No product specified
PPG	No product specified	No product specified	No product specified
Sherwin Williams	Sher-Plate	None Applied	Sher-Plate
Tnemec	Series 22	None Applied	Series 22
Service Condition	Immersed, moderately corrosive environment in contact with Potable Water.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP5, White Metal Blast Cleaning. Shop primed surfaces: SSPC-SP7, Brush-Off Blast Cleaning. Damaged primer or rust: SSPC-SP5, White Metal Blast Cleaning and spot prime.		
Surface Profile			
Ferrous Metal	2.0 to 2.5 mils		
Primed surfaces	1.0 to 1.5 mils on the intact primer.		
System Thickness (Dry Film)			
Total	16 to 25 mils		
Application			
Special CTR Training	Required.		

Attachment B			
Coating Detail Sheet			
Coating System	EPX-M-6-BG		
Coating Material	Epoxy		
Substrate	Metal		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carboguard 890
International Paint	Bar-Rust 236	Bar-Rust 236	Bar-Rust 236
PPG	Amerlock 2/400 Series	Amerlock 2/400 Series	Amerlock 2/400 Series
Sherwin Williams	Tank Clad HS	Tank Clad HS	Tank Clad HS
Tnemec	Series 69	Series 69	Series 69
Service Condition	Below grade in contact with soil.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	SSPC-SP10, Near White Metal Blast Cleaning.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface Profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	16 mils		
Primer	4 to 6 mils		
Intermediate Coat	4 to 6 mils		
Finish Coat	4 to 6 mils		
Application			
General	Fill all bugholes with a filler/surfacer compatible with the coating.		
Special CTR Training	Not required.		

Attachment B			
Coating Detail Sheet			
Coating System	VE-C-1		
Coating Material	Vinyl Ester - fiber reinforced with flexible basecoat		
Substrate	Concrete		
Products: One of the following or equal:	Primer	Intermediate Coat	Finish Coat
International Paint	Manufacturer's recommended	Ceilcote Flakeline 232.	Ceilcote Flakeline 232.
PPG	Manufacturer's recommended	Nova Rez 370	Nova Rez 370
Sherwin Williams	Manufacturer's recommended	CorCote VEN	CorCote VEN
Tnemec	Manufacturer's recommended	Series 252 SC	Series 252 SC
Service Condition	Immersed, non-immersed, very corrosive environment, color not required, new or existing construction. Primary or secondary containment indoors or exterior. Provide flexible base coat and fiberglass reinforcing to bridge concrete cracks up to 50 mils.		
General	Prepare surfaces as specified in this Section and as follows.		
Concrete	Apply flexible complete parge coat over all concrete surfaces after surface preparation is accepted. Completely fill all bugholes with the same material. Brush blast clean, if parge coat is non-polymer modified, after adequate cure per CSM's instructions to produce a uniform anchor pattern. Let concrete substrate cure under warm conditions (minimum of 75 degrees F) for at least 5 days before coating application if using wet abrasive or water jet surface preparation. Sawcut 1/4" minimum deep groove and provide coating termination and transition details as shown on the drawings and in accordance with CSM's standard details including terminations, transitions at corners, cracks, pipe penetrations, terminations at metal embedments, and other details. Vacuum all surfaces to be coated after surface preparation and curing to remove all loose dirt, dust, or other loose materials.		
Existing Coated Concrete	Prepare as for new concrete. Apply a skim coat of a surfacer or filler material to restore the substrate to a coatable condition.		
Surface Profile			
Concrete	ICRI CSP 5.		
Existing Coated Concrete	ICRI CSP 5.		
System Thickness (Dry Film)			
Parge Coat	Completely cover the substrate with flexible parge coat above filled voids by 1/8 inch (125 mils) of thickness.		
Total	60 to 65 mils in addition to the parge coat.		
Primer	Per CSM's recommendations.		
Intermediate Coat	25 to 30 mils with 1.5 oz fiberglass cloth. Saturate fiberglass and roll flat with a wet ribbed roller. Sand all seams flat and remove protruding fiberglass strands.		
Finish Coat	25 to 30 mils. Broadcast 20 to 40 mesh silica sand or aluminum oxide into the wet finish coat to saturation. Remove excess with stiff bristle broom after curing.		
Application			
General	Trowel-apply surfacers or filler materials CSM's recommendations. Work surfacer/filler into all voids to displace air and fill bugholes.		
Special CTR Training	Required.		